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BULLETIN OF THE IMPERIAL INSTITUTE

A QUARTERLY RECORD OF PROGRESS IN TROPICAL AGRICULTURE AND INDUSTRIES AND THE COMMERCIAL UTILISATION OF THE NATURAL RESOURCES OF THE COLONIES AND INDIA

EDITED BY THE DIRECTOR AND PREPARED BY THE SCIENTIFIC AND TECHNICAL STAFF OF THE IMPERIAL INSTITUTE AND BY OTHER CONTRIBUTORS

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VOL. XII. 1914

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p. 144, line 31, *for* Mr. R. S. Troup, F.L.S., *read* Mr. R. S. Pearson, F.L.S.

BULLETIN OF THE IMPERIAL INSTITUTE

VOL XII. 1914

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THE IMPERIAL INSTITUTE

OF THE

UNITED KINGDOM, THE COLONIES, AND INDIA

THE Imperial Institute was erected at South Kensington as the National Memorial of the Jubilee of Queen Victoria, by whom it was opened in May 1893.

The principal object of the Institute is to promote the utilisation of the commercial and industrial resources of the Empire by arranging comprehensive exhibitions of natural products, especially of the Dominions, Colonies, and India, and providing for their investigation, and for the collection and dissemination of scientific, technical, and commercial information relating to them.

Until the end of 1902 the Imperial Institute was managed by a Governing Body, of which H.R.H. the Prince of Wales (afterwards King Edward VII.) was President, and an Executive Council, including representatives of the Indian Empire and of all the British Colonies and Dependencies. In 1900 the building became the property of H.M. Government, by whom the western portion and galleries were leased to the Governing Body of the Imperial Institute, the greater part of the eastern and central portions being assigned, subject to certain rights of usage by the Imperial Institute, for occupation by the University of London. In July 1902 an Act of Parliament was passed transferring the

management of the Imperial Institute to the Board of Trade, assisted by an Advisory Committee including representatives of the Dominions, Colonies, and India, as well as of the Colonial and India Offices, the Board of Agriculture, and the Board of Trade. This Act took effect on January 1, 1903.

On October 1, 1907, in virtue of an arrangement made with the Board of Trade and with the approval of the Secretary of State for India, the management of the Imperial Institute was transferred to the Secretary of State for the Colonies, subject to the responsibility of the Board of Trade under the Act of 1902. A Committee of Management of three members, one nominated by each of the three Government Departments chiefly concerned, has been appointed, and at present consists of Mr. C. A. Harris, C.B., C.M.G., M.V.O.; Sir Alfred Bateman, K.C.M.G.; and Sir John P. Hewett, G.C.S.I., C.I.E.

The first Director of the Imperial Institute was Sir Frederick Augustus Abel, Bart., G.C.V.O., K.C.B., F.R.S., who held the office until his death in the autumn of 1902. The present Director is Professor Wyndham Dunstan, C.M.G., M.A., LL.D., F.R.S., who was appointed in 1903.

The staff of the Imperial Institute includes officers with special qualifications in the sciences of chemistry, botany, geology, mineralogy, and in certain branches of technology, in their relation to agriculture and to the commercial utilisation of economic products.

A Report by the Director on the Work of the Imperial Institute is presented to Parliament annually.

The following are the principal departments of the Institute:

Exhibition Galleries.—The collections of economic products, etc., illustrative of the general and commercial resources of the Dominions, Colonies, and India, are

arranged, together with other exhibits, on a geographical system in the public galleries of the Imperial Institute, which are open free to the public daily, except on Sundays, Good Friday, and Christmas Day, from 10 a.m. to 5 p.m. (10 a.m. to 4 p.m. in winter.)

The following British Dominions, Colonies, and Dependencies are represented by Collections, which are in charge of Technical Superintendents:

Canada, Newfoundland; Jamaica, Turks and Caicos Islands, British Honduras, British Guiana, Bahamas, Trinidad and Tobago, Barbados, Windward Islands, Leeward Islands, Bermuda; Falkland Islands; New South Wales, Victoria, Queensland, Tasmania, South Australia, Western Australia, Papua, New Zealand; Fiji, Western Pacific Islands; Union of South Africa, Rhodesia, Nyasaland, St. Helena; Gambia, Sierra Leone, Gold Coast, Nigeria; East Africa Protectorate, Zanzibar and Pemba; Uganda; Somaliland; the Anglo-Egyptian Sudan; Malta; Cyprus; Ceylon; Hong Kong; Mauritius; Seychelles; Straits Settlements, the Federated Malay States; and India.

Special arrangements are made to conduct parties from schools and institutions through the Colonial and Indian Collections for educational purposes.

A Central Stand for Publications and an Enquiry Office have been opened in the centre of the main gallery to facilitate the supply of general information and the distribution of literature. Handbooks, pamphlets, circulars, etc., containing information relating to the commerce, agriculture, mining, and other industries of the principal British Colonies, and also to emigration, are available for gratuitous distribution or for sale. The publications of the Emigrants' Information Office, established by the Colonial Office, may also be obtained. Lists of the publications available for distribution or sale are pro-

vided, and the principal Colonial and Indian newspapers may be seen on application. An officer of the Institute is in attendance at this stand, which is in telephonic communication with the Departments in the main building.

In 1913 the public galleries were visited by 214,900 persons, and 19,910 Colonial and Indian publications were distributed.

Scientific and Technical Research Department.—The research laboratories and workrooms of this Department were established in order to provide for the investigation of new or little-known natural products from the Colonies and India and of known products from new sources, with a view to their utilisation in commerce, and also to provide trustworthy scientific and technical advice on matters connected with the agriculture, trade, and industries of the Colonies and India.

The work of this Department is chiefly initiated by the Home and Colonial Governments and the Government of India. Arrangements have been also made by the Foreign Office, whereby British representatives abroad may transmit to the Department for investigation such natural products of the countries to which they are appointed as are likely to be of interest to British manufacturers and merchants.

Materials are first investigated in the research laboratories of the Department, and are afterwards submitted to further technical trials by manufacturers and other experts, and finally are commercially valued.

A Reference Sample Room is maintained in this Department, in which are arranged samples of the principal materials which have been investigated and valued commercially during recent years, and as to which full information is available.

The Department works in co-operation with the Agricultural, Mines and other technical Departments in

the Colonies, whose operations it supplements by undertaking such investigations as are of a special scientific or technical character connected with agricultural or mineral development, as well as enquiries relating to the composition and commercial value of products (animal, vegetable, or mineral) which can be more efficiently conducted at home in communication with merchants and manufacturers, with a view to the local utilisation of these products or to their export.

A very large number of reports on these subjects have been made to the Governments of the Colonies and India, a first instalment of which was printed in a volume of *Technical Reports and Scientific Papers*, published in 1903. A series of Selected Reports is now being issued in the Miscellaneous Series of Colonial Reports. Of these Selected Reports, five have been published: Part I. "Fibres" (Cd. 4588), Part II. "Gums and Resins" (Cd. 4971), Part III. "Food Stuffs" (Cd. 5137), Part IV. "Rubber and Gutta Percha" (Cd. 6022), Part V. "Oil-seeds, Oils, Fats and Waxes" (Cd. 7260).

Mineral surveys, under the supervision of the Director of the Imperial Institute, and conducted by Surveyors selected by him, are in progress in several countries. All minerals found which are likely to be of commercial importance are forwarded to the Imperial Institute, where they are examined and their composition and commercial value ascertained. Reports by the Director on the results of mineral exploration in Ceylon, Northern Nigeria, Southern Nigeria, and Nyasaland have been printed in the Miscellaneous Series of Colonial Reports.

Tropical African Services Course.—A course of instruction in certain specified subjects is now given at the Imperial Institute to candidates selected by the Colonial Office for administrative appointments in East and West Africa.

Instruction in the subject of Tropical Economic Products in this Course is given by a member of the staff of the Imperial Institute.

Library and Reading-Rooms.—The library and reading-rooms of the Imperial Institute contain a large collection of Colonial and Indian works of reference, and are regularly supplied with the more important official publications, and with many of the principal newspapers and technical periodicals of the United Kingdom, the Dominions, the Colonies, India, and Foreign countries.

The library and reading-rooms are on the first floor, and admittance to them is obtained through the entrance at the west (Queen's Gate) end of the building. These rooms are available for the use of Life Fellows of the Imperial Institute, and of other persons properly introduced. Books and newspapers may be consulted for special purposes by permission.

Colonial Conference Rooms.—Three rooms, specially decorated and furnished, are reserved on the principal floor for use by representatives of the Colonies for meetings and receptions.

The Cowasjee Jehanghier Hall.—The Bhownagree corridor and rooms in connection with this hall are in the occupation of the Indian Section of the Imperial Institute, whilst the hall is available for lectures, meetings, etc.

The "Bulletin of the Imperial Institute" is published quarterly by Mr. John Murray, 50A, Albemarle Street, London, price 2*s.* 6*d.* (annual subscription 11*s.*, including postage), and may be purchased through any bookseller or from agents in the Colonies and India. The BULLETIN contains records of the principal investigations conducted

for the Colonies and India at the Imperial Institute, and special articles chiefly relating to progress in tropical agriculture and the industrial utilisation of raw materials (animal, vegetable, and mineral).

Imperial Institute Handbooks on Tropical Resources.—The Secretary of State for the Colonies has authorised the preparation of a series of handbooks dealing with the Commercial Resources of the Tropics, with special reference to West Africa. The handbooks are edited by the Director of the Imperial Institute, and published by Mr. John Murray. The first three volumes are: *The Agricultural and Forest Products of British West Africa*, by Gerald C. Dudgeon, Director-General of Agriculture in Egypt, and lately Inspector of Agriculture for British West Africa, price 5*s.* net; *Cocoa: Its Cultivation and Preparation*, by W. H. Johnson, F.L.S., Director of Agriculture in Southern Nigeria, price 5*s.* net; and *Rubber: Its Sources, Cultivation, and Preparation*, by Harold Brown, Technical Superintendent, Scientific and Technical Department, Imperial Institute, price 6s. net.

The following Societies have their offices at the Imperial Institute:

International Association for Tropical Agriculture, British Section.—The object of this Association, the Central Bureau of which is in Paris, is the promotion of the scientific and practical study of all questions connected with tropical agriculture and the development and utilisation of natural resources, especially of tropical countries. The British Section has its headquarters at the Imperial Institute. Members of the British Section are permitted to use the library and reading-rooms of the Imperial Institute, and a writing-room has been also

provided for their use. The Association will hold an International Congress of Tropical Agriculture in London from the 23rd to the 30th June, 1914. The British Section will be responsible for the organisation of this Congress.

British Women's Emigration Association.—The British Women's Emigration Association has been assigned offices on the mezzanine floor, which are open daily from 10 a.m. to 4 p.m. Advice and information respecting emigration and prospects for women in the Colonies may be obtained there free of charge. This Association works in co-operation with the Emigrants' Information Office in Westminster.

Colonial Nursing Association.—An office has been allotted on the mezzanine floor to this Association. The principal object of the Association is the selection of trained hospital and private nurses for service in the Crown Colonies and Dependencies.

Tropical Diseases Bureau.—Temporary office accommodation on the mezzanine floor has been provided for this Bureau, the main purpose of which is to collect information regarding tropical diseases and to distribute it as widely as possible among those who are engaged in combating such diseases.

Bureau of Universities of the British Empire.—An office on the mezzanine floor has been allotted to this Bureau, the object of which is the collection and dissemination of information relating to the Universities of the British Empire.

THE IMPERIAL INSTITUTE

Trustees

The First Commissioner of His Majesty's Treasury.
The Secretary of State for the Colonies.
The Secretary of State for India.
The President of the Board of Trade.

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(Appointed under the provisions of the Imperial Institute Transfer Act, 1902)

	Appointed by
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Right Hon. Sir C. Clementi Smith, G.C.M.G. C. A. Harris, Esq., C.B., C.M.G., M.V.O.	The Secretary of State for the Colonies.
Sir T. H. Holland, K.C.I.E.	The Government of India.
F. C. Drake, Esq. Sir K. G. Gupta, K.C.S.I.	The Secretary of State for India.
Sir Sydney Olivier, K.C.M.G.	The Board of Agriculture.
(*Vacant*)	The Government of the Dominion of Canada.
Captain R. H. Muirhead Collins, C.M.G.	The Federal Government of the Commonwealth of Australia.
(*Vacant*)	The Government of the Union of South Africa.
Hon. Thomas Mackenzie.	The Government of the Dominion of New Zealand.

Secretary, G. C. L. Maunder, Esq.

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Sir A. E. Bateman, K.C.M.G.	Nominated by the Board of Trade.
Sir J. P. Hewett, G.C.S.I., C.I.E.	Nominated by the India Office.

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Wyndham R. Dunstan, Esq., C.M.G., M.A., LL.D., F.R.S.

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Mineral Surveys.—*Ceylon:* J. S. Coates, B.A. (Cantab.); E. J. Wayland, F.G.S.

Mozambique Company's Territory: E. O. Thiele, M.Sc. (Melbourne), F.G.S.; R. C. Wilson, B.Sc. (Melbourne), F.G.S.

State of Gwalior, Central India: Douglas R. Home, F.G.S.; S. M. Owen, A.R.S.M., F.G.S.; E. J. Parsons, B.Sc., F.G.S.

Exhibition Galleries.—Colonial and Indian Collections. *Technical Superintendents:* S. E. Chandler, D.Sc. (Lond.), F.L.S.; H. Spooner; A. B. Jackson. *Assistant Technical Superintendents:* F. W. Rolfe, D. J. Taylor.

Labour Staff.—Foreman: J. Foster.

Tropical African Services Course

Instructor in Tropical Economic Products: S. E. Chandler, D.Sc. (Lond.), F.L.S.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial, Indian, and other Governments concerned.

SOME ECONOMIC PRODUCTS OF SOMALILAND

THE exports of Somaliland are valued at about 3,250,000 rupees (£217,000 approx.) per annum and include ostrich feathers, leather, hides, live-stock, ghee (clarified butter), guano, pearls, mother-of-pearl shells, Sansevieria fibre, myrrh, frankincense, and gums.

The three last-mentioned items are of considerable interest, since comparatively little has been known until recently regarding the trees which yield them, and even now the information available is by no means complete. It is therefore of interest to place on record the results of examination of a series of authentic samples of products of these and allied types, which was collected by Dr. Drake-Brockman, of the Somaliland Medical Service, and sent to the Imperial Institute for examination. Botanical specimens of the plants yielding many of these products were also collected by Dr. Drake-Brockman and sent to the Royal Botanic Gardens, Kew, for investigation, and this work is still in progress.

With reference to the native names assigned to these products, it may be explained that the name "hăbbak" is a generic name applied by the Somalis to all products of these classes, the various kinds being distinguished by the addition of the vernacular names of the trees from which the products are derived, thus; "habbak adad" is

the gum of the "adad" tree (*Acacia Senegal*, Willd.). In certain cases, however, an alternative name is used. Thus the tree yielding myrrh is called "didin" (pronounced didthin), but the name "habbak didin," which would, according to the general rule, be used for myrrh, is replaced by "malmal," and the two varieties of myrrh produced in the country are distinguished by prefixing the names of the regions in which they are collected, thus "Ogo malmal" and "Guban malmal," the former being obtained in Ogo, the high internal plateau region, and the latter being collected in Guban, the low-lying maritime plains.

The materials received at the Imperial Institute belonged to three different classes, viz. true gums, gum-resins, and resins. As there is considerable confusion in the application of these terms, it may be explained that in this report the term gum is restricted to products completely miscible with water and forming more or less viscous solutions. The resins, on the contrary, are insoluble in water, but dissolve to a greater or less extent in other liquids such as alcohol or turpentine oil, whilst the gum-resins are natural mixtures of gum and resin, and consequently are only partially soluble in water, the portions insoluble in this liquid being usually soluble in alcohol, turpentine oil, or some similar solvent. Some of the gum-resins also contain small quantities of essential oils, *i.e.* odoriferous oils, that can be separated from the gum and resin by placing the crude product in water and treating it with a current of steam.

The present investigation had for its first object the classification of these products into the three groups thus briefly described. This having been done, each product was further examined to determine its quality and value, if any. In recording the results of this work it is convenient to discuss the products under the three groups to which they belong.

In the following pages the introductory matter relating to the various products has been derived from Dr. Drake-Brockman's book, *British Somaliland* (see this BULLETIN, p. 159), and, in the case of the gums, also from notes kindly furnished by him.

Gums

In order that a gum of the "arabic" type may be of commercial value it should be completely soluble in water, of pale colour, and devoid of unpleasant taste or characteristic odour. Its solution in water should also be viscous and possess good adhesive properties. For further information on this subject the Selected Reports from the Scientific and Technical Department of the Imperial Institute, Part II., Gums and Resins (Colonial Reports, Miscellaneous [Cd. 4971], 1909) should be consulted.

Habbak adad.—This gum, the product of *Acacia Senegal*, Willd. (*A. Verek*, G. and P.), the tree which also yields the best gum in the Anglo-Egyptian Sudan, Senegal, and Nigeria, is stated to be the best of the Somali acacia gums. It is found in "tears" or globular masses, varying in size from that of a cherry to a turkey's egg, and except in the case of pieces which are old or have been exposed to the weather for some months, is usually translucent and nearly colourless. Even in the larger old pieces there is seldom more than a flesh-pink tinge. This gum is largely exported; it is carefully collected, seldom being mixed with other and inferior varieties, and is brought to the coast in goat-skin bags. It is cleaned in Aden, whence the better quality is shipped to Europe, while the remainder goes to Bombay. *A. Senegal* is found all over British Somaliland, but more commonly in Ogo. It is a medium-sized, ragged tree, which seldom exceeds 10 to 12 ft. in height.

Two samples of this gum were received at the Imperial Institute and were examined, with the following results:

No. 1.—This consisted of tears of transparent, clean, "glassy" gum, varying in colour from pale straw to pale pinkish-brown, and having a vitreous fracture.

No. 2.—This sample, which was stated to be an old specimen of "habbak adad," consisted of tears, pieces of large tears, and small fragments of clean, transparent, "glassy" gum, varying from nearly colourless to pinkish-brown. The mucilage was nearly colourless and possessed good adhesive properties.

The samples were submitted to chemical examination,

with the following results, compared with samples of *A. Senegal* gum from the Sudan, Senegal, and Nigeria previously examined at the Imperial Institute (this BULLETIN, 1908, **6**, 38; 1910, **8**, 359; this vol. p. 31).

	No. 1.	No. 2.	Sudan gum.	Senegal gum.	Nigerian gum.
Moisture . . *per cent.*	13·6	12·3	11·3 to 13·2	16·0 to 16·1	10·2 to 13·5
Ash . . . . *per cent.*	2·4	4·0	3·1 to 3·3	3·0 to 3·5	2·8 to 3·5
Matter insoluble in water *per cent.*	2·9	6·0	—	—	0·1 to 1·9
[1] Acid number . . .	2·2	3·6	1·2 to 2·4	0·8 to 1·9	3·2 to 3·3
Specific rotation at 20° C., in water . . .	−33° 40′	−23° 10′	—	—	−23° 40′ to −26° 50′
[2] Relative viscosity of a 10 per cent. solution at 22° C. .	7·2	20·1	16·3 to 31·4	22·5 to 32·4	5·36 to 6·66

[1] *Milligrams of potassium hydroxide required to neutralise* 1 *gram of gum.*
[2] *As compared with* 1 *for water, determined under the same conditions.*

Sample No. 2 showed the usual characters of old gum, in containing more "insoluble matter" and in having a higher viscosity.

Samples of both gums were submitted to brokers, who classed No. 1 as "clean, palish, glassy" gum arabic, and valued it at 27*s.* 6*d.* per cwt. in London (March 1913), with "glassy" Sudan gum arabic at 31*s.* per cwt. and "bas du fleuve" Senegal gum at 81 francs per 100 kilos. in Bordeaux, while No. 2 was valued at 30*s.* per cwt. (August 1913).

Habbak wadi.—The species of acacia which yields this gum has not yet been determined. The gum is of good quality and inferior only to "habbak adad." It is found in globules which vary in size from that of a pea to that of a pigeon's egg or even larger, and is sometimes seen in large, irregularly shaped masses. The small pieces are usually colourless and translucent, but the larger pieces are often pinkish-yellow or brown in colour. This gum is brought down to the coast either unmixed with other varieties or mixed with "habbak adad," which it somewhat resembles. The "wadi" tree grows only in Western Somaliland, where it extends for miles along the banks of the large rivers, being common on the banks of the Webi Shebeleh, Ganale, Wabi, and Juba. The tree reaches a height of 20 ft., and possesses a whitish bark.

The specimen received at the Imperial Institute was collected in the Ogaden country, and consisted of small tears and fragments of gum, varying from nearly colourless to pale reddish-brown.

This gum was soluble in water. The mucilage was reddish-brown, and possessed good adhesive properties.

The gum was analysed, with the following results:

Moisture	*per cent.*	12·0
Ash	*per cent.*	3·6
Matter insoluble in water	*per cent.*	1·0
Acid number		5·3
Relative viscosity of a 10 per cent. solution at 22·0° C.		6·3

This sample was valued by brokers at 24*s.* to 25*s.* per cwt., less 2½ per cent. discount, in London (August 1913).

Unnamed gum.—No information was supplied as to the botanical source of this sample. It consisted of small tears and pieces of "glassy" gum, soluble in water and mostly of a pale colour, but in some cases reddish-brown. The mucilage was reddish-brown, and possessed good adhesive properties.

On analysis, the sample gave the following results:

Moisture	*per cent.*	12·2
Ash	*per cent.*	3·6
Matter insoluble in water	*per cent.*	2·9
Acid number		6·0
Relative viscosity of 10 per cent. solution at 22·0° C.		7·8

This gum was valued by brokers at 23*s.* to 24*s.* per cwt., less 2½ per cent. discount, in London (August 1913). It was quite similar to "habbak adad" No. 1 (see p. 13), and its lower value was due chiefly to its darker colour.

Habbak hinni.—The species of acacia which yields this gum has not yet been determined. The gum is occasionally found mixed with "habbak adad," and occurs in colourless translucent "tears," in large, irregular, yellowish-red pieces, or in reddish, globular masses. It can never be collected in large quantity, as the trees are not numerous and the gum is only exuded in small quantities. The "hinni" acacia is found in the Guban (the maritime plain) and in

the Haud. It is a low-growing tree, and seldom exceeds 3 to 4 ft. in height.

The sample examined at the Imperial Institute consisted of small masses, tears, and fragments of gum, varying in colour from pale straw to dark reddish-brown. A few pieces of "burnt" gum were also present. The gum was soluble in water, and the mucilage possessed good adhesive properties.

The gum was analysed, with the following results:

Moisture	*per cent.*	12·5
Ash	*per cent.*	3·6
Matter insoluble in water	*per cent.*	1·1
Acid number		4·8
Specific rotation at 20° C. in water		−47° 20′
Relative viscosity of 10 per cent. solution at 22·0° C.		6·1

This sample was valued by brokers at 15*s.* to 17*s.* 6*d.* per cwt., less 2½ per cent. discount, in London (August 1913). Gum of this type, free from "burnt" and dark-coloured fragments, would fetch a much better price.

Habbak billeil.—This gum is also obtained from an undetermined species of acacia, and is usually found in more or less globular masses, which vary in size from that of a cherry to that of a hen's egg, and are translucent and of reddish or brownish tint. It is not collected by the Somalis except for eating. The "billeil" tree does not exceed 12 ft. in height, and is a ragged-looking acacia not unlike the "adad" (*A. Senegal*). It grows freely in the internal plateau, where it is one of the commonest of the acacias. It seems to prefer the less stony areas of this region.

A sample of this gum, collected at Gondar Libah and Gubato in Ogo, was received. It consisted of irregular tears and fragments of translucent gum, varying in colour from pale brown to dark red-brown. The mucilage possessed good adhesive properties.

The gum was analysed, with the following results:

Moisture	*per cent.*	11·2
Ash	*per cent.*	2·8
Matter insoluble in water	*per cent.*	1·7
Acid number		5·4
Relative viscosity of a 10 per cent. solution at 22·0° C.		16·0

This gum was valued by brokers at 10s. per cwt., less 2½ per cent. discount, in London (August 1913).

As regards the following six varieties of gums, it should be mentioned that it is not by any means certain that the samples received at the Imperial Institute are typical, but examination of the further specimens which Dr. Drake-Brockman has promised to collect will probably decide this point. In this connection it may be pointed out that *A. Seyal*, which is stated to be the source of "habbak gurha" (p. 18), yields the "talh" gum of the Anglo-Egyptian Sudan, which is saleable in London, though at rather low prices under normal conditions.

Habbak jerin.—This gum is derived from a species of acacia not yet determined. It is stated to be of little or no value, and, when brought to the coast, is invariably found mixed with "habbak adad." It is only found in small quantities, in small, irregular, friable pieces varying in colour from a dull lemon-yellow to a sherry tint. It is eaten by the Somalis. The "jerin" tree is common on the maritime plain, known as Guban, and the higher lands, called Ogo-Guban. It seldom grows more than 3 or 4 ft. in height. The green seed-pods are eaten by the Somalis, as are also the roasted seeds.

The material received consisted of clear, long, irregular tears, varying in colour from pale to dark brown. The gum was not completely soluble in water. Such material, owing to its dark colour, would be difficult to sell in competition with gum of the same quality as the "habbak adad" described above.

Habbak sog-sog.—The "sog-sog" acacia has not yet been identified. The gum is always of a crimson or claret colour, and the pieces are irregular and seldom larger than a pigeon's egg. It is of no commercial value, but it is occasionally gathered by the nomad Somalis and eaten, being one of the few dark-coloured gums that are used in this way. The "sog-sog" tree is found both on the maritime hills and in the interior, where it grows best on stony ground and on the low, table-topped hills. It is a ragged tree, which grows to a height of 10 to 12 ft.

The sample received was stated to have been collected

on the Golis range and at Debbi in Ogo. It consisted of dark brown masses of agglomerated tears of gum, which, when treated with water, swelled to a gelatinous mass ("insoluble" gum). The gum represented by this sample would be of little or no commercial value on account of its dark colour and "insolubility."

Habbak gurha.—This gum, stated to be the product of *A. Seyal*, is of a dark port-wine colour when freshly exuded, but when old is almost black. It is seldom seen in lumps or pieces of any considerable size, but in elongated tears either on the trees or collected on the ground under the trees. The gum is not collected for export, and is only eaten by the Somalis when fresh. The "gurha" tree is the largest of the Somali acacias, and is most commonly seen on the banks of the larger rivers, where there is a more or less permanent subterranean source of water. In favourable localities it grows to a height of 25 to 30 ft. or more, and can be seen growing at its best on the river banks at Hargeisa, Burao, and Odweina.

The material received consisted of small pieces of dark-coloured and "burnt" gum of no commercial value (see, however, note on p. 17 as to the value of the gum yielded by *A. Seyal*).

Habbak giyato.—No information is available as to the source of this gum or as to the extent of its occurrence in Somaliland.

The specimen received was stated to have been obtained from a tree found on hills in Ogo. It consisted of one small tear of gum, which appeared to have become rather "burnt." It represented material of no commercial value.

Habbak harriri.—In this case also no information is available as to the botanical source of the gum. The sample examined was stated to have been obtained from Charabwim, near Obbia. It consisted of a few irregular tears of brown gum with much adherent bark.

Habbak obol.—The botanical source of this gum was not stated. The sample received was collected near Odweina, and consisted of conglomerated masses of elongated tears of very dark brown (almost black), glassy, transparent gum. Some bark was present. The sample

was soluble in water, but yielded a dirty purple-brown solution. The gum was too dark in colour to be of commercial value.

Gum-Resins

A number of products of this class find application in medicine or perfumery, e.g. myrrh, "opoponax," and frankincense or olibanum, and new gum-resins are as a rule of little commercial value unless they can be used as substitutes for products of this type already known in commerce, or possess some special property, such as fragrance, which will enable them to be used in perfumery or in preparing incense. The gum-resins from Somaliland now under report include samples of myrrh, frankincense, and "opoponax," as well as samples of "bdellium," all of which are more or less known in commerce. In all cases where the samples were large enough, the percentages of gum (matter soluble in water), resin (matter soluble in alcohol), and volatile oil (matter volatile in a current of steam) have been determined, and notes are recorded as to the character of these constituents. Where products known in commerce are concerned, the results of similar work already published on other samples are added for comparison, and commercial valuations by experts of the present samples are given.

Myrrh.—Two kinds of myrrh are found in Somaliland: "Ogo malmal," which is collected in the Haud, Nogal Valley, and Ogaden in the far interior, and "Guban malmal," collected in the low-lying, sun-parched coast regions and on the maritime hills. The first-named is of superior quality and is the "Turkey" myrrh of commerce. It fetches about double the price of "Guban malmal" on the local markets. The question of the botanical sources of the two varieties has not been definitely settled, but Dr. Drake-Brockman states that herbarium specimens of the coast and of the inland trees were both identified at Kew as *Balsamodendron Myrrha*, Nees, whilst both trees are known to the Somalis by the name of "didin." If the two varieties of myrrh are derived from one species, the differences exhibited by the two products must be

due to the different climatic conditions under which the trees grow. The "Ogo malmal" is found in irregular lumps, with a drier and more dusty appearance than the coast variety. The "Guban malmal" occurs in irregular masses made up of numberless "tears" or "drops," varying in size from that of a pin's head to that of a pea, the mass always having an oily appearance.

Samples of both varieties of myrrh were received for examination.

No. 1. *Myrrh* (*Ogo malmal*).—Large, irregularly shaped pieces of gum-resin, yellowish-brown and opaque externally, and brown and resinous internally. The fracture was brittle, oily, and irregular. The substance had the pleasant, fragrant odour and the bitter, nauseous taste characteristic of myrrh.

The sample yielded a deep red, transparent resin, which was almost tasteless, and a yellow, fragrant oil, which was mobile when freshly distilled but which changed rapidly on keeping to a stiff sticky substance of resinous appearance.

For the results of the chemical examination of this and some of the other gum-resins see table on p. 25.

No. 2. *Myrrh* (*Guban malmal*).—Brown irregular pieces of gum-resin, almost free from bark, and resembling the preceding sample No. 1 (Ogo malmal) in odour and taste. The sample yielded resin and oil similar in appearance to those obtained from No. 1. The oil from the present sample did not, however, become so stiff on keeping.

These two samples of myrrh approximated closely in character to commercial samples of "Aden" and "Somali" myrrh respectively, with which they were compared.

Habbak haddi.—This is the most important of all the Somali varieties of "bdellium" and is sometimes called "perfumed bdellium." According to Mr. E. M. Holmes, F.L.S., the tree yielding this gum-resin is *Commiphora erythræa* var. *glabrescens*, Engler. It is one of the largest of the desert trees and is found only in the western districts of Somaliland, especially in the Ogaden, Rer Amaden, and Aulihan countries. The gum-resin is known

to the Indian traders as "Bissa bol" and is exported to Bombay and from thence goes to China. It is invariably seen in large, irregular lumps of much the same colour as myrrh, except that small whitish areas are always present. It has a very powerful and distinctive odour, quite unlike that of myrrh, but is just as oily, if not more so, than Guban myrrh. Habbak haddi is the product now used in Europe as opoponax.

The specimen examined consisted of irregular pieces of semi-translucent gum-resin, varying in colour from light to dark brown and mottled with opaque yellowish matter. The pieces were hard and dry externally, but soft and oily internally.

The material possessed a strong, fragrant odour. It yielded a dark yellowish-red, transparent resin, which softened readily on warming. The volatile oil was a yellow, mobile liquid, which had a peculiar and fragrant smell, and did not resinify or turn dark on keeping.

Habbak hagar.—This is a somewhat rare "bdellium," sometimes found mixed with Guban myrrh. It is said to be derived from *C. Hildebrantii*, Engler. The tree is common on the maritime hills to the south of Berbera as far as the Golis range, and grows to a height of 10 to 12 ft. in suitable localities. The gum-resin resembles Guban myrrh in colour, but is less oily, and more brittle.

The sample examined consisted of very dark brown, semi-transparent, irregular pieces of gum-resin, together with some small pieces of a pale colour. The material had no marked odour, but possessed an intensely bitter taste. The sample was too small for detailed examination.

Habbak malo wa harod.—This closely resembles Guban myrrh, with which it is frequently found mixed. The tree, which has not yet been identified botanically, seldom exceeds 4 ft. in height, and when stunted resembles that yielding myrrh. It is found both at the coast and in the interior.

The specimen received consisted of two irregular tears of brownish gum-resin, possessing a very slight fragrance. It was too small for detailed examination.

Habbak daseino.—This is the product of *C. Opobalsamum*, Engler. The gum-resin is distinctly rare, and is never collected for export, although the tree is common enough, being found in the same localities as the myrrh ("didin") tree. The gum-resin is used by the Somalis for chewing, and also for burning in the huts to drive out flies, as in the case of frankincense, and for this reason is sometimes called by the same name as the latter, viz. "hanjibeyo."

One large tear of this gum-resin was received. It was dark brown in colour, and possessed an odour recalling that of elemi, but more fragrant. The sample was too small for detailed examination.

Habbak hodai.—This is the commonest of the opaque bdelliums. It is obtained from *C. Playfairii*, Hook., a tree common on the maritime mountains to the south and south-east of Berbera, as far as the Golis range, and in the Haud, Nogal Valley, and Ogaden; it grows to a height of 7 or 8 ft.

The gum-resin is found in irregular masses, which vary in size and colour according to their age: in the fresher or more recently exuded pieces the colour is a dirty milky white, but older pieces, which have been exposed to the weather, are of a dull reddish colour.

Two samples of this gum-resin were received.

No. 1.—Conglomerated masses of cream-coloured and brownish opaque gum-resin, which possessed a slight fragrance. A good deal of dirt, bark, etc., was present. The sample yielded a resin in the form of a cream-coloured mass, which did not melt below 100° C., but when heated with water gave an opalescent liquid. The resin was tasteless.

This sample contained no volatile oil, and would be classed as an "opaque bdellium."

No. 2.—Opaque, cream-coloured tears, small, opaque chips, and irregular, conglomerated masses of cream-coloured and brown gum-resin, which possessed a slight fragrance, and closely resembled the preceding sample of "Habbak hodai (opaque bdellium)." Some bark was present.

The material yielded a resin similar to that given by the preceding sample, and also contained no volatile oil.

Habbak dunkal.—This bdellium is very rare, being only sparingly found on the "dunkal" tree, the botanical identity of which has not yet been established. The tree is always found on rocky ground, such as the maritime mountains, and seldom exceeds 4 to 5 ft. in height. The gum-resin, which is said by the Somalis to be very poisonous, possesses a hard and usually roughened and cracked exterior, whilst the interior is opaque, dull, and yellowish-red, not unlike beeswax; when thoroughly dry it becomes very hard.

The specimen examined consisted of small, buff-coloured, opaque tears of gum-resin, with a rough surface, mixed with irregular, dark brown, opaque fragments of gum-resin. A few pieces of bark were present.

The sample yielded a yellowish-brown, transparent resin with a somewhat bitter taste, and contained no volatile oil. It resembled in appearance the samples of "habbak hodai" examined, and would probably be classed as an "opaque bdellium."

Frankincense.—Two varieties of frankincense are exported from Somaliland, viz. "Loban maidi" and "Loban dakar." The former is obtained from the "yehar" tree (*Boswellia Frereana*, Birdw.), which is commoner in the Warsangeli and Mijertain regions than elsewhere, but is sparingly found in the Habr Toljaala country. "Loban dakar" is derived from the "mohor" tree (*B. Carteri*, Birdw.), which is found only on maritime hills and mountains in the Habr Toljaala, Warsangeli, and Mijertain countries. "Loban maidi" is always of a pale topaz-yellow colour; it occurs in tears or in large, flat, irregular pieces, showing white, powdery streaks, and is very apt to stick together when tightly packed. The other variety of frankincense (Loban dakar) is always found in separate small tears, which seldom agglomerate when packed in bags. Both varieties, as collected by the natives, are mixed with foreign matter, and they are usually cleaned in Aden, the picked samples of "Loban maidi" going mostly to India and Egypt, whilst those of "Loban dakar" are sent

to Europe. The inferior qualities of each kind are shipped back to Africa, most of it finding its way to Abyssinia.

Samples of both varieties of frankincense were received for examination.

No. 1. *Loban maidi,* 1*st quality.*—Irregular lumps of straw-coloured gum-resin, with an opaque coating but transparent internally, and possessing a pleasant terebinthous odour. The fracture was friable and resinous. Some of the lumps had thin, buff-coloured stems running through the gum-resin, while other lumps had thin, papery, buff-coloured bark attached to them.

The sample yielded a light brown, brittle, glassy, tasteless resin, and a yellow, mobile, volatile oil with a fragrant terebinthous odour. The oil contained no phellandrene. It had the following constants:

Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	0·859
Refractive index at 23° C.	1·464
Specific optical rotation $[\alpha]_D^{15}$	+ 11° 50′

This material closely resembled the "Luban mayeti" described by Flückiger and Hanbury (*Pharmacographia,* p. 153), which is said to be derived from *B. Frereana.* It contained very little gum, and had a lower acid number and saponification number than "Loban dakar" (see table, p. 25).

No. 2. *Loban dakar,* 1*st quality.*—Tears and masses of pale buff-coloured, semi-opaque, brittle gum-resin, possessing a sweet smell and a slight taste. The sample yielded a yellowish-brown, transparent, tasteless resin, and a yellow, mobile, volatile oil which had a terebinthous odour, and which did not thicken on keeping. The quantity of oil obtainable was insufficient for examination.

The results of the analyses of eight of the foregoing samples of gum-resin are given in the following table. The samples of "habbak hagar," "habbak malo wa harod," and "habbak daseino" were too small for detailed examination. The corresponding figures for samples of "Aden" and "Somali" myrrh and of frankincense (olibanum) are added for comparison:

Results of Chemical Examination

	Myrrh I. Ogo malmal.	Myrrh II. Guban malmal.	Commercial myrrh, Aden type.	Commercial myrrh, Somali type.	Habbak haddi.	Habbak hodai (1).	Habbak hodai (2).	Habbak dunkal.	Frankincense. Loban maidi.	Frankincense. Loban dakar.	Commercial frankincense (olibanum).
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	10·2	10·5	8·9	12·9	22·2	8·1	8·9	5·3	5·2	10·5	8·1
Ash	3·0	5·2	18·0	4·4	2·8	12·8	6·5	2·4	0·6	1·2	1·3
Volatile oil	13·8	11·8	(not determined)		10·6	nil	nil	nil	5·3	2·8	(not determined)
Resin, soluble in alcohol	31·7	29·7	31·0	22·3	41·4	59·9	65·1	64·6	88·9	61·6	66·9
Matter insoluble in alcohol	54·5	58·5	60·1	64·8	36·4	32·0	26·0	30·1	5·8	27·9	25·0
Consisting of:											
Matter soluble in water (gum)	52·1	56·8	36·2	58·6	20·9	17·7	17·7	26·0	3·1	23·4	21·2
Matter insoluble in water (chiefly dirt)	2·4	1·7	23·9	6·2	15·5	14·3	8·3	4·1	2·7	4·5	3·8
Acid number	26·5	17·8	19·0	40·5	29·5	23·6	26·9	13·0	5·0	23·6	36·0
Saponification number	143·0	130·0	97·0	120·0	111·0	58·0	59·0	164·0	23·0	60·0	102·0

Commercial Valuation of the Gum-Resins

Seven of the foregoing samples of gum-resin were submitted to a firm of London brokers, who valued them in March 1913 as follows:

Myrrh (Ogo malmal).—The brokers stated that this sample contained some fine-quality myrrh worth fully £5 per cwt., but they classed the remainder as "common drossy," and considered that on account of this the average value of the sample would be about 55*s.* to 60*s.* per cwt. in London.

Myrrh (Guban malmal).—Of good quality, and worth about 60*s.* to 65*s.* per cwt.

Habbak haddi.—The brokers classed this as "bdellium," and regarded it as of fair quality and nominally worth about 6*d.* to 8*d.* per lb.

"Habbak haddi" is the material now used in commerce as a source of opoponax oil. A sample of the "habbak haddi" gum-resin was therefore also submitted to a firm of essential oil distillers, who reported that the oil distilled from the material showed approximately the constants established for the pure oil of opoponax of commerce. They stated that it was difficult to give a reliable valuation

of the resin, as prices vary according to the appearance, the yield of oil, and the aroma of the material. They considered, however, that a price of from 60*s.* to 75*s.* per cwt. c.i.f. London (February 1913) would represent a fair average value. It will be seen that this range of prices is much the same as that of the value "6*d.* to 8*d.* per lb." assigned to the gum-resin by the firm of brokers to whom it was submitted in London.

Habbak hodai (*opaque bdellium*).—Of no value on the London market.

Frankincense (*Loban maidi*).—The brokers classed this as "thus," and stated that it would be saleable in small quantities at 25*s.* per cwt.

Frankincense (*Loban dakar*).—This was classed as "olibanum, fair greenish drop," and was valued at 35*s.* per cwt.

Resins

Hanjikulan.—This resin is said to be obtained from an undetermined species of Balanites which is common in the maritime region to the south and south-west of Bulhar. The resin is not collected for export, but is used for chewing. The products of two other species of Balanites, viz. "hanjigoad" from *B. orbicularis* and "hanjikidthi" from *B. ægyptiaca*, are also collected. These three resins are difficult to distinguish, as they possess a similar odour and all are found in tears or globular pieces varying in size from that of a cherry to that of a pigeon's egg, the smaller ones being of a dark greenish-yellow colour, while the larger pieces are deep orange-red.

The sample of "hanjikulan" received consisted of tears and masses of tears of greenish-brown, friable, transparent resin, with a pleasant but not very strong odour. The ground resin turned dark green on exposure to light. On analysis the resin gave the following results:

	Per cent.
Moisture	3·6
Ash	0·3
Volatile oil	6·0
Resin, soluble in alcohol	96·0
Matter insoluble in alcohol	trace
Acid number	24·7
Saponification number	64·0

The resin soluble in alcohol was yellowish-brown, transparent, and practically tasteless. The volatile oil was yellow and mobile when freshly distilled, but thickened on keeping; it had a fragrant and rather pungent odour.

This resin is unknown in European markets, and consequently has no commercial value at present. It possesses certain interesting chemical properties, and a detailed examination of it will be made when opportunity offers.

GUMS FROM NORTHERN NIGERIA

In previous numbers of this Bulletin (1908, **6**, 47; 1910, **8**, 353), an account has been given of the gum industry of Northern Nigeria, together with the results of examination at the Imperial Institute of a series of gums derived from various species of acacia from that country. In the following pages the gums of two species of acacia are dealt with, viz. *Acacia campylacantha*, Hochst., and *A. Sieberiana*, DC., as well as a consignment of "Kol-kol" gum (*A. Senegal*, Willd.), which was forwarded to the Imperial Institute for sale in London.

"*Golawai*" *gum* (*A. campylacantha*, Hochst.). Three samples of this gum from the Bornu Province were received in February 1912.

Grade A consisted of glassy gum varying in colour from pale straw to reddish-brown. A small quantity of dirt (fragments of leaves and bark) was present.

Grade B closely resembled the preceding, but contained fewer dark coloured pieces of gum.

Grade C closely resembled B, but consisted of smaller fragments and was rather paler in colour.

All three gums gave a pale yellow mucilage possessing good adhesive properties. They were examined, with the following results:

	Grade A.	Grade B.	Grade C.
Moisture . . . . . *per cent.*	10·6	10·7	10·6
Ash . . . . . *per cent.*	3·6	3·4	3·4
Matter insoluble in water, *per cent.*	1·2	1·1	2·2
Acid number [1]	2·5	2·2	1·9
Relative viscosity of a 10 per cent. solution at 22° C. [2]	11·7	13·1	8·8

[1] *Milligrams of potassium hydroxide required to neutralise 1 gram of gum.*

[2] *As compared with 1 for water, determined under the same conditions.*

"Golawai" gum, as represented by these three samples, would be classified commercially as "semi-insoluble" gum, and would be worth from 15*s.* to 17*s.* 6*d.* per cwt. when saleable. There is, however, little demand for such gum as long as typical soluble gums, such as the "kol-kol" (*A. Senegal*, Willd.) and "karumga" (*A. Seyal*, Del.) gums are obtainable in quantity at cheap rates.

"*Katalabu*" *gum* (*A. Sieberiana*, DC.)—Two samples of this gum, Grades A and B, from the Bornu Province, were received at the same time as the samples of "golawai" gum. Both consisted of glassy gum varying in colour from straw to reddish-brown, but on the whole darker than the "golawai" gums described on page 27. A small quantity of bark was present in Grade A.

The results of examination of the two grades of "katalabu" gum are shown in the following table:

		Grade A.	Grade B.
Moisture	*per cent.*	10·3	10·2
Ash	*per cent.*	2·3	2·1
Matter insoluble in water	*per cent.*	1·8	1·3
Acid number		3·9	4·4
Relative viscosity of a 10 per cent. solution at 22° C.		4·7	5·7

Both samples gave a yellowish-brown mucilage possessing good adhesive properties.

These results show that this variety of gum is of promising quality. Both samples were valued by brokers at 22*s.* 6*d.* to 24*s.* per cwt., with "glassy Khartum" gum at 31*s.* per cwt. (April 1913).

General Conclusions

Herbarium specimens of the four kinds of gum trees said to exist in Northern Bornu, and samples of the gums yielded by them, have now been received at the Imperial Institute and examined. "Karumga" and "kol-kol" gums were dealt with in a report published in this Bulletin (1910, **8**, 352) and "golawai" and "katalabu" gums in the present report. The results of this work may be briefly summarised as follows:

Native name of tree.	Scientific name.	Nature of gum.	Commercial value of gum.
"Karumga"	*A. Seyal*, Del.	Soluble	19*s*. to 30*s*. per cwt. according to grade (January 1910).
"Kol-kol"	*A. Senegal*, Willd.	Soluble	24*s*. to 28*s*. per cwt. according to grade (January 1910).
"Golawai"	*A. campylacantha*, Hochst.	Semi-insoluble	15*s*. to 17*s*. 6*d*. per cwt. (April 1913).
"Katalabu"	*A. Sieberiana*, DC.	Soluble	22*s*. 6*d*. to 24*s*. per cwt. (April 1913).

These results show that although good prices can be obtained for selected gum from the "karumga" tree, (*A. Seyal*), the best gum-yielding species in Northern Nigeria, as in the Sudan and Senegal, is "kol-kol" (*A. Senegal*). In collecting gum for export it is very important that inferior gum such as that yielded by "golawai" (*A. campylacantha*) should not be mixed with the better qualities of gum, such as that furnished by "kol-kol" trees, or those obtained from "karumga" or "katalabu" trees.

With regard to the samples of all these gums forwarded to the Imperial Institute, it may be pointed out that better prices are obtained for consignments of gum where these consist of pieces which are uniform in size and colour and are free from dust, and that it is not worth while attempting to divide gum into grades unless these points are attended to. Thus none of the so-called "grades" of gum dealt with in this or the previous report would be regarded as distinct grades in the United Kingdom, since they all consisted of gum varying in colour and flavour and in size of pieces.

In a report by Mr. Beckles Gall, Acting Resident, Bornu, sent to the Imperial Institute in 1908, two other trees which yield a kind of gum are mentioned, viz. "kingur" and "kindil." Herbarium specimens of both these trees were forwarded with the series of samples now under report. The specimen representing "kingur" was incomplete and could not be identified, and a further herbarium specimen of the tree has been asked for. "Kindil" was identified at the Royal Botanic Gardens, Kew, from the herbarium specimen submitted, as *A. Seyal*, Del., which would make it identical with "karumga" (*loc. cit.*

p. 357). It seems clear, from Mr. Beckles Gall's statement already mentioned, that "karumga" and "kindil" are distinct species, and a further herbarium specimen of each of these two trees has been requested in order that this discrepancy may be cleared up. A sample of "kindil" gum has also been requested for examination. A sample of "kingur" gum was forwarded with the series of samples now dealt with, but this proved to be a mixture of products, which cannot all have been obtained from the same species of tree. It has been suggested, therefore, that a further sample of this gum from authenticated "kingur" trees should be collected and forwarded for examination.

Commercial Consignment of "Kol-kol" Gum

The consignment of "kol-kol" gum, derived from *A. Senegal*, Willd., which is the subject of this report, weighed about 13 cwt., and was received at the Imperial Institute in July 1913.

The consignment, as received at the Imperial Institute, consisted of three grades of gum, contained in forty cases. The inner bags in which most of the gum had been packed were found to have been injured in transit, with the result that the outer packing, consisting of seed-cotton and straw, had become mixed with the gum; and it was necessary to clean the gum at the Imperial Institute before it could be analysed or sold.

The three grades of gum after cleaning were as follows:

Grade I.—This sample consisted of tears, broken tears, and fragments of clean gum, varying from nearly colourless to light brown, but on the whole pale in colour. The gum was mostly of the "glassy" type, with a small admixture of opaque gum.

This gum resembled a sample of "kol-kol large grade" gum previously examined at the Imperial Institute (this Bulletin, 1910, **8**, 357), but was somewhat darker in colour. It was completely soluble in water. The resulting mucilage was of pale straw colour, and possessed good adhesive properties.

Grade II.—Clean gum, similar in appearance to Grade I, but in smaller fragments, of paler colour and containing

more opaque gum. It closely resembled the sample of "kol-kol medium grade" gum previously examined at the Imperial Institute (*loc. cit.*).

This gum was completely soluble in water. The resulting mucilage was of pale straw colour, and possessed good adhesive properties.

Grade III.—This consisted mostly of fragments and dust of pale-coloured gum, and resembled the sample of "kol-kol small grade" gum previously examined at the Imperial Institute (*loc. cit.*).

The gum was completely soluble in water. The mucilage was of pale straw colour, and possessed good adhesive properties.

Samples of the three grades were analysed at the Imperial Institute with the following results:

	Grade I.	Grade II.	Grade III.
Moisture . . . . *per cent.*	13·3	13·5	13·1
Ash . . . . . . *per cent.*	3·3	3·3	3·5
Matter insoluble in water . *per cent.*	0·1	0·2	0·4
Acid number	3·2	3·3	3·2
Specific rotation in water . . .	−26° 20′ at 20° C.	−26° 50′ at 20° C.	−26° 10′ at 21° C.
Relative viscosity of a 10 per cent. solution at 22° C.	6·2	6·4	6·4
Specific gravity of a 10 per cent. solution at $\frac{15° C.}{15° C.}$	1·035	1·036	1·037

The gum, after cleaning, was submitted to a firm of merchants in London, who purchased the three grades in one lot on December 19, 1913, at the price of 30*s.* per cwt., less 2½ per cent. discount.

The merchants reported that the gum was of very desirable quality, closely resembling Kordofan gum in appearance, although rather darker in solution, and that it should be useful for all purposes for which Kordofan gum is employed. They added that Grades II and III had perhaps been partially bleached in the sun. It is clear from these results that Nigerian "kol-kol" gum, carefully collected and prepared for the market, will realise good prices in London.

FIBRES FROM VARIOUS SOURCES

In the following pages an account is given of the results of examination of a number of fibres received at the Imperial Institute in recent years, the materials being arranged according to their industrial uses.

Fibres Suitable for Coarse Textiles

Jute from India

The four samples of jute dealt with in this report were received in July 1912. They were grown on experimental plots at Dacca, Bengal, and were examined chiefly with a view to determining the relation between the strength of the fibres and their chemical properties, especially the loss on hydrolysis and the percentage of cellulose.

No. 1.—Clean, fine, buff-coloured fibre of good lustre. It was of very good strength and varied in length from 4 ft. 7 in. to 5 ft. 5 in., with an average of 5 ft. 1 in. This appeared to be the best of the four samples.

No. 2.—Buff-coloured fibre, of good lustre, soft and clean, except for occasional gummy portions at the root ends. It was rather weaker than the preceding sample. The length varied from 4 ft. 2 in. to 5 ft. 9 in., with an average of 5 ft.

No. 3.—Buff-coloured fibre, not so lustrous as sample No. 2. It was of uneven strength, being rather poor on the whole, and varied in length from 4 ft. 6 in. to 6 ft. 8 in., with an average of 6 ft. 2 in.

This jute was somewhat inferior to samples 1, 2, and 4.

No. 4.—Buff-coloured fibre of good lustre. It was of good strength, and varied in length from 5 ft. 6 in. to 6 ft. 8 in., with an average of 5 ft. 10 in. This sample appeared to be rather inferior to No. 1, but superior to Nos. 2 and 3.

The chemical examination of these fibres gave the following results, which are compared with those given by "extra fine" Indian jute.

	No. 1.	No. 2.	No. 3.	No. 4.	"Extra fine" Indian jute.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	11·7	11·5	11·4	12·45	9·6
Ash	0·52	0·84	0·69	0·65	0·7
α-Hydrolysis, loss	7·6	7·9	8·9	8·0	9·1
β-Hydrolysis, loss	11·3	12·2	13·1	12·3	13·1
Cellulose	78·4	76·4	75·2	77·6	77·7
Length of ultimate fibres.	From 0·06 to 0·14 in.; average, 0·096 in.	From 0·08 to 0·12 in.; average, 0·092 in.	From 0·06 to 0·16 in.; average, 0·088 in.	From 0·06 to 0·12 in.; average, 0·092 in.	From 0·06 to 0·12 in.

Attempts were made to determine the breaking stress of these fibres by means of a testing machine, but the experiments had to be abandoned as it was found that no useful or trustworthy results could be obtained in this way, on account of the peculiar nature of the fibre. It was impossible, for example, to obtain single filaments suitable for the test, owing to the fact that the filaments are not continuous, but may be split up into two or more finer strands at various points in their length.

A comparison of the tensile strength of the fibres was therefore effected by hand, and it was found that No. 1 was the strongest, followed by the others in the order 4, 2, 3. In the following table, the samples are arranged in this order, and the losses sustained on hydrolysis and the percentages of cellulose are compared :

	α-Hydrolysis, loss *per cent.*	β-Hydrolysis, loss *per cent.*	Cellulose, *per cent.*
No. 1	7·6	11·3	78·4
No. 4	8·0	12·3	77·6
No. 2	7·9	12·2	76·4
No. 3	8·9	13·1	75·2

An examination of this table shows that the strength is closely related to the percentage of cellulose and also to the hydrolysis constants.

The length of the ultimate fibres of these samples was quite normal in each case, the range previously recorded for jute being from 0·06 to 0·12 in.

Malachra capitata *Fibre from India*

Two samples of this fibre have been received, the first in August 1909 and the second in November 1912.

No. 1.—Nearly white, lustrous fibre, fairly well cleaned, but containing patches of barky matter. The root ends were uncut. The fibre was of good strength, with an average length of 6 ft.

No. 2.—Fairly soft, very lustrous, almost white fibre, well cleaned and prepared, but rough and coarse at the root ends. It was rather uneven in strength, ranging from fair to weak. The length varied from 7 to 8 ft.

The results of examination of these two fibres are shown in the following table, together with the figures obtained for a sample previously examined at the Imperial Institute (see *Technical Reports and Scientific Papers*, 1903, p. 68).

	No. 1.	No. 2.	Previous samples.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	11·1	10·8	12·5
Ash	0·8	0·4	1·0
α-Hydrolysis, loss	10·0	9·7	12·3
β-Hydrolysis, loss	15·0	13·3	17·8
Acid purification, loss	0·9	0·4	2·6
Cellulose	74·4	75·1	74·2
Length of ultimate fibres	—	From 0·06 in. to 0·1 in.; average, 0·08 in.	—

The fibre represented by these samples would be readily saleable in the United Kingdom as a substitute for ordinary jute. Sample No. 1 was valued at £13 per ton with "first native marks" Calcutta jute at £15 per ton (November 1909), but if it had been better cleaned and the root ends cut off the value would have been increased to about £16 or £17 per ton. Sample No. 2 was valued at £30 per ton in London, with "first marks" Calcutta jute at £26 5*s.* to £26 10*s.* per ton (February 1913) and in this case also the value would have been increased if a few inches of the root ends had been cut off. The merchants who valued the second sample stated that they would be glad to receive shipments of the fibre for sale in London.

Urena lobata *Fibre from India*

A sample of *Urena lobata* fibre from India was received in November 1912. It consisted of fairly soft, cream-coloured fibre, of good lustre. The sample was well

cleaned and prepared, but rough and coarse at the root ends. The strength was rather uneven, but fair on the whole. The length varied from 7 ft. to 9 ft., with an average of 8 ft.

The fibre was examined with the following results:

	Per cent.
Moisture	10·6
Ash	0·3
α-Hydrolysis, loss	9·4
β-Hydrolysis, loss	13·4
Acid purification, loss	1·1
Cellulose	77·5
Length of ultimate fibres	From 0·06 to 0·16 in.; average 0·09 in.

This fibre was of good spinning quality, and could be spun in conjunction with the finest grades of Calcutta jute. The sample was valued by merchants at £35 per ton in London, with "first marks" Calcutta jute at £26 5*s.* to £26 10*s.* per ton (February 1913).

A small consignment of *U. lobata* fibre, weighing 5¼ cwts., was received in March 1913. It consisted of fairly soft, fine, lustrous fibre, varying in colour, but chiefly of a cream tint, with a greenish or brownish tinge in parts. The fibre was fairly well cleaned and prepared up to about 1 ft. from the root ends; the latter were of a greyish colour, and contained many pieces of closely adherent bark. The strength of the fibre was rather uneven, varying from fair to rather weak. The length of staple varied from 4 ft. to 6 ft. 8 in., but was mostly between 5 and 6 ft.

This fibre was of about equal strength and lustre to the previous sample of *U. lobata* fibre, but it was not so regular in colour nor so well cleaned and prepared; it was also of shorter staple.

About 6 in. of the root ends of this fibre should be cut off, and baled separately for shipment. If this were done the rest of the fibre would be enhanced in value, whilst the root ends would find a market for paper making.

The consignment was sold in London, together with the second consignment of Sida fibre referred to below (see p. 36), at the rate of £36 per ton. On the date of the sale "first native marks" Calcutta jute was quoted at £35 10*s.* to £36 per ton. For an account of the spinning qualities of this fibre, see p. 37.

Sida Fibre from India

A description of this Indian fibre has already been given in this BULLETIN (1912, **10**, 218). Since that date two small consignments have been received at the Imperial Institute for sale.

No. 1.—This consisted of a bale of fibre and was received in April 1912. It was placed for disposal with a firm of merchants in London, who described the fibre as fine and soft and of very bright white colour, similar to fine white jute, but rather weaker. The full value of the fibre was estimated to be £28 to £30 per ton in London, but they pointed out that it is always difficult to get buyers to pay the full value for sample bales of fibre, and that consequently a lower price would probably have to be accepted. It was ultimately sold at the rate of £27 per ton.

No. 2.—This consignment, weighing about 5¼ cwts., was received in March 1913. It consisted of fine, soft, lustrous fibre, varying in colour from pale brownish-yellow to pale straw. The material was fairly well cleaned and prepared, but it still contained many pieces of closely adherent bark. The length of the staple varied from 3 to 6 ft., but was mostly from 5 to 6 ft. The strength was fairly good.

Compared with a previous sample of Sida fibre from India (*loc. cit.*), the present sample was of somewhat better strength and of equal lustre, but its colour was not so regular, and it was not so well cleaned and prepared. It was also shorter, the previous sample having been from 6 to 8 ft. long.

This consignment of Sida fibre was sent for sale to a firm of merchants in London, who valued it at from £32 to £33 per ton, but stated that if properly cleaned and prepared it would realise £40 per ton in London (August 18, 1913).

The fibre was ultimately sold, together with the consignment of *Urena lobata* fibre (see p. 35), at the rate of £36 per ton. On the date of sale "first native marks" Calcutta jute was quoted at £35 10*s.* to £36 per ton.

The spinners who purchased the Sida and Urena fibres reported that they spun very well. One firm stated that no

trouble whatever was experienced in their trials with the material, and that it can be mixed with other fibres. A second spinner reported that the fibre did not spin quite so well as Bengal jute, as it was liable to run into small places, giving a weaker yarn, so that the yarn would probably only be suitable for weft.

As the two fibres were sold and spun together, it was not possible to state which of them alone would give the better results, but presumably they are about equal in spinning quality.

The merchants stated that these Sida and Urena fibres are the nearest substitute for Bengal jute that has ever come into the market, and that spinners would welcome supplies from India. They considered that the fibres should be readily saleable at a fraction under the price of "first marks" Calcutta jute, and anticipated that if some sacrifice in the price were made at first in order to get them introduced on the market, they would eventually bring a higher price than "first marks" jute, provided that the quality was equal to that of the present trial consignments.

Fibre from Southern Nigeria

A sample consisting of two bundles of clean, fairly lustrous, pale straw-coloured ribbons of bast fibre was received in December 1911. The individual strands were closely interlaced, and frequently broke at the junctions when any attempt was made to separate them. As received, the ribbons measured from 5 to 6 ft. in length, but on combing they were reduced to strands varying in length from under 1 ft. to 4 ft. The strength of the fibre was mostly good, but rather uneven.

The fibre was examined with the following results, compared with those given by a sample of "Kowe" fibre from Sierra Leone and "extra fine" Indian jute:

	Present sample. *Per cent.*	"Kowe" fibre from Sierra Leone. *Per cent.*	"Extra fine" Indian jute. *Per cent.*
Moisture	10·1	11·5	9·6
Ash	0·5	0·2	0·7
α-Hydrolysis, loss	8·2	6·0	9·1
β-Hydrolysis, loss	13·2	8·5	13·1
Acid purification, loss	0·5	0·2	2·0
Cellulose	78·7	78·0	77·7

2*

The sample was valued nominally at from £19 to £21 per ton, with China jute at £17 to £19 per ton (March 1912).

This fibre was very similar to jute in chemical behaviour, as is evident from a comparison of the figures obtained on chemical examination with those furnished by a sample of "extra fine" Indian jute; it was, however, harsher and not so lustrous as jute. It closely resembled in appearance "Kowe" fibre (*Hibiscus quinquelobus*) from Sierra Leone, and was very similar to it in chemical behaviour, although more susceptible to the action of hot dilute alkali (α- and β-hydrolysis).

The fibre was probably derived from a species of *Hibiscus*. It was coarser than jute, and possessed the disadvantage of the interlacing character, which, as already stated, caused the fibre to break up when combed. In these respects it closely resembled "Kowe" fibre.

In connection with the nominal price quoted for the fibre, it may be mentioned that there has been considerable variation between the valuations of samples of "Kowe" fibre by commercial experts, and the prices realised at the sale of small consignments, these variations depending on fluctuations in the market prices of jute and Manila hemp. "Kowe" and similar fibres can be spun with jute, but they are not very satisfactory for this purpose, and will therefore only be purchased by jute-spinners when very high prices are ruling for the latter fibre. They can also be utilised by rope-makers when Manila hemp is very dear.

Rama Fibre from Northern Nigeria

"Rama" fibre is produced in Northern Nigeria from the stems of *Hibiscus lunariifolius*. It is reported that an increasing quantity is now being shipped to the United Kingdom.

Two samples of this fibre from Northern Nigeria have been examined at the Imperial Institute.

No. 1.—Brownish-white fibre, on the whole well cleaned, but in parts very gummy and badly cleaned; it possessed a good lustre, but was too harsh for a jute substitute. It was

of good strength, and varied in length mostly from 4 to 7 ft., but some was only 3 ft. long.

No. 2.—Well-cleaned, jute-like fibre of good lustre, and mostly of a pale straw colour, with some portions, especially the root ends, buff-coloured. It was of good strength, with an average length of about 8 ft.

The samples were examined with the following results, as compared with those given by "extra fine" Indian jute:

	No. 1.	No. 2.	"Extra fine" Indian jute
	Per cent.	*Per cent.*	*Per cent.*
Moisture	8·5	10·5	9·6
Ash	0·4	0·8	0·7
α-Hydrolysis, loss	7·4	9·5	9·1
β-Hydrolysis, loss	10·2	12·8	13·1
Acid purification, loss	0·4	1·1	2·0
Cellulose	76·8	77·0	77·7

Sample No. 1 was valued at £12 per ton, with "common" jute at £11 to £12 per ton (May 1909), while No. 2 was regarded as worth £16 to £17 per ton as a jute substitute, with "first native marks" at £14 7*s.* 6*d.* per ton (February 1910).

The results of examination of these fibres compared above with those for "extra fine" Indian jute, show that the three samples closely resemble one another in chemical composition and behaviour. Sample No. 2 was less harsh than the No. 1, and could be used as a substitute for jute. It would be readily saleable in the United Kingdom.

Cordage Fibres

Sisal Hemp from the Federated Malay States

A considerable number of samples of Sisal hemp from various countries have been examined at the Imperial Institute, and the results of examination of some of these have been published in previous numbers of this Bulletin. Among these may be mentioned samples from Rhodesia (1904, **2**, 168), Sierra Leone (1907, **5**, 107), East Africa Protectorate, Uganda, and Nyasaland (1909, **7**, 160), Portuguese East Africa (1912, **10**, 131), Mauritius (1910, **8**, 9), India (1906, **4**, 25; 1909, **7**, 11; 1912, **10**, 216), and Papua (1912, **10**, 214).

The sample of Sisal hemp which is the subject of the present report was received at the Imperial Institute in

September 1913. It was desired that the fibre should be examined and valued, and that its tensile strength, in particular, should be determined.

The sample consisted of lustrous fibre, fairly well cleaned and prepared, but of slightly uneven colour, varying from cream to brownish-yellow, and generally considerably darker in tint than is usually the case with Sisal hemp. The length of staple varied from 2 ft. 8 in. to 6 ft., with an average of 4 ft. 3 in.

The fibre was submitted to chemical examination with the following results, compared with corresponding figures for a sample of Sisal hemp from the East Africa Protectorate:

	Present sample.	Sisal hemp from the East Africa Protectorate.
	Per cent.	*Per cent.*
Moisture	12·0	11·1
Ash	0·8	1·0
α-Hydrolysis, loss	11·3	11·2
β-Hydrolysis, loss	20·1	14·1
Acid purification, loss	1·9	2·3
Cellulose	77·1	78·2

The length of the ultimate fibres varied from 0·06 to 0·29 in., with an average of 0·19 in.

The dark colour of the fibre as received at the Imperial Institute was found to be due to the presence of iron, which may have been derived either from the water used in washing or from the scraping instruments used in preparing the fibre. After removing this iron by the use of chemicals, the washed and dried fibre was of a light cream colour.

The fibre was also examined for tensile strength and elongation in comparison with a standard sample of Sisal hemp from East Africa. Using a length of 20 cm. of fibre for the tests, the following average results were obtained:

	Present sample.	Sisal hemp from East Africa.
Breaking stress in grams	618	1,102
Extension before breaking, *per cent.*	4·5	2·0

Taking the East African Sisal hemp as the standard, the ratios are as follows:

	Present sample.	Sisal hemp from East Africa.
Breaking stress	56	100
Extension	225	100

The above figures indicate that the present sample has only 56 per cent. of the strength of the East African Sisal hemp, but that it is 2¼ times as extensible as the latter.

The fibre was submitted to a firm of merchants, who valued it at £25 per ton in London, with Mexican Sisal at £26 per ton (December 1913).

Fibre of this quality would be saleable in large quantities for cordage manufacture. A more valuable product could probably be obtained by extracting the leaves with modern machinery and brushing the fibre produced.

Aloe Fibre from Bechuanaland

A sample of fibre thought to be derived possibly from *Aloe Lugardiana* was received in October 1913. It consisted of lustrous, fairly fine, soft fibre, of pale straw colour, and well cleaned and prepared. It was of fairly good strength, and varied in length from 1 ft. 8½ in. to 3 ft. 1½ in., but was mostly about 2 ft. 6 in.

It was examined with the following results, which are compared with those given by Sisal hemp from the East Africa Protectorate.

	Present sample. *Per cent.*	Sisal hemp from East Africa. *Per cent.*
Moisture	10·6	11·1
Ash	1·4	1·0
α-Hydrolysis, loss	14·3	11·2
β-Hydrolysis, loss	17·9	14·1
Acid purification, loss	5·6	2·3
Cellulose	71·6	78·2
Length of ultimate fibres	From 0·03 to 0·14 in.; average, 0·07 in.	From 0·04 to 0·16 in.; average, 0·10 in.

This fibre was valued at £27 to £28 per ton in London (December 1913). It was of very good appearance and of fairly good strength, and would probably be saleable in the United Kingdom as a cordage material, although it is rather short for this purpose. The low percentage of cellulose and the rather high loss on hydrolysis indicate that the fibre was somewhat inferior to Sisal hemp in respect of chemical composition and behaviour, and that it would probably prove to be less durable.

"Crowa" Fibre from British Guiana

A sample of "Crowa" fibre was received from British Guiana in March 1909. The exact botanical source of the fibre was not known, but it was stated to be derived from a Bromeliad and possibly a species of *Ananas* or *Karratas*.

The fibre was fine, very pale straw-coloured, without much lustre, but very well cleaned. The strength was somewhat uneven, but on the whole was very good. The length varied from 4 ft. to 5 ft. 6 in.

On examination the fibre gave the following results compared with those yielded by pineapple fibre from the Gold Coast.

	"Crowa" fibre. *Per cent.*	Pineapple fibre from the Gold Coast. *Per cent.*
Moisture	9·9	9·5
Ash	0·6	1·1
α-Hydrolysis, loss	12·3	13·7
β-Hydrolysis, loss	16·1	19·4
Acid purification, loss	1·8	1·7
Cellulose	84·1	81·5
Length of ultimate fibres	From 0·20 to 0·44 in., with an average of 0·28 to 0·32 in.	—

This fibre is suitable for rope making and would be readily saleable on the London market. It was valued at £24 per ton (October 1909).

The results of the chemical examination show that this "Crowa" fibre is superior to the sample of pineapple fibre (*Ananas sativus*) from the Gold Coast, since it contains a larger proportion of cellulose and suffers a smaller loss on boiling with dilute alkali (α- and β-hydrolysis). It is probable, therefore, that the "Crowa" fibre would be very durable and able to resist the prolonged action of water.

Paper Making Materials

Nipa Palm Leaves from Sarawak

The results of examination of Nipa palm petioles and fibre from the Federated Malay States, as paper making materials, have already been published in this Bulletin (1912, **10**, 376).

In July 1913 the following samples were received for examination from Sarawak.

No. 1. "*Stem of Nipa Palm.*"—This was apparently a portion not of the stem, but of the midrib of a leaf. It measured 15½ in. in length and about 1½ in. in diameter.

No. 2. "*Old leaves of Nipa Palm.*"—The sample consisted of three "leaves" (pinnæ) measuring from 5 ft. to 5 ft. 10 in. in length and from 4 to 4¼ in. across at the widest part.

No. 3. "*Young leaves of Nipa Palm.*"—This consisted of (*a*) a bundle of four leaves measuring from 5 ft. 3 in. to 5 ft. 9 in. in length and from 3½ in. to 4 in. across at the widest part, and (*b*) a bundle of six smaller leaves measuring from 4 ft. 7 in. to 4 ft. 11 in. in length and from 1⅝ in. to 2 in. across at the widest part.

Sample 1 and a mixture of samples 2 and 3 were examined in detail with the following results, which are compared with the corresponding figures for commercial esparto grass from Oran, Algeria:

	Sample 1. *Per cent.*	Samples 2 and 3. mixed. *Per cent.*	Algerian esparto grass. *Per cent.*
Moisture (in air-dry material)	16·1	14·1	8·8
Ash (on material dried at 100–110° C.)	8·2	3·6	3·0
Yield of unbleached pulp dried at 100–110° C.:			
(1) Expressed on air-dry material	27·7	20·0	29·5
(2) Expressed on material dried at 100–110° C.	33·0	23·8	32·3
Loss on bleaching	*	14·6	1·3
Yield of bleached pulp dried at 100–110° C. expressed on original material dried at 100–110° C.	*	20·3	32·0
Length of ultimate fibres	From 0·02 to 0·073 in.; average 0·048 in.	From 0·012 to 0·09 in.; average 0·036 in.	From 0·012 to 0·12 in.; average 0·045 in.

* *The quantity of pulp available was too small for the loss on bleaching to be determined in this case.*

The yield of pulp from the leaves (samples 2 and 3 mixed) was lower than that from Algerian esparto grass, whilst in the case of the "stems" or midribs (sample 1) the yield of unbleached pulp was about equal to that of esparto grass. The ultimate fibres from the "stems" (midribs) were equal in average length to those of Algerian esparto grass, whilst in the case of the leaves they were a little shorter. All the samples were readily convertible

into a brown pulp, and laboratory trials made at the Imperial Institute showed that a fairly good paper could be prepared from this pulp. The paper yielded by the leaves was not quite so strong as that obtained from the midribs.

The material represented by the present samples would not be of any commercial value in Europe except for paper making, and in order to ascertain its precise value for this purpose large-scale technical trials would have to be carried out. The material is too bulky and yields too little pulp to allow shipment to Europe in the crude state, but if the results of the technical trials were satisfactory it could either be exported from Sarawak in the form of "half stuff" or used locally for the manufacture of paper.

Scilla rigidifolia *Leaves from Swaziland, South Africa*

The leaves of *S. rigidifolia*, which are the subject of this report, were forwarded to the Imperial Institute by the Department of Agriculture at Pretoria in November 1911. It was stated that the plant grows in large quantities in Swaziland, and it was desired to ascertain its commercial value.

The sample weighed about 10 lb., and consisted of dry, rather brittle leaves.

The leaves contained a fair proportion of fibre, which, however, was very weak, and could not be profitably extracted for textile purposes. It is possible, however, that the leaves might find a market as a material for paper making, and they were examined at the Imperial Institute from this point of view.

The following table gives the results of the chemical examination of the leaves of *S. rigidifolia*, together with the corresponding figures for a sample of Algerian esparto grass:

	S. rigidifolia leaves. *Per cent.*	Algerian esparto grass. *Per cent.*
Moisture	9·5	8·8
Ash	3·8	3·0
Pulp (expressed on material as received)	32·0	29·5
Pulp (expressed on dried material)	35·4	32·3
Length of ultimate fibres of pulp	0·032 to 0·064 in.; average, about 0·04 in.	0·012 to 0·12 in.; average, about 0·045 in.

The dried pulp contained about 92 per cent. of cellulose. The ultimate fibres were narrow, pointed at the ends, and thick-walled, the lumen in some cases being almost obliterated.

These results show that the leaves of *S. rigidifolia* yielded a larger proportion of pulp than the sample of esparto grass with which they were compared, although the ultimate fibres of the pulp were somewhat shorter. It is therefore probable that the dry leaves would be saleable for paper making at a price approximating to that of Algerian esparto grass.

It is obvious that at this price the collection and exportation of the leaves of *S. rigidifolia* would not be profitable. It might, however, be possible to employ the leaves for paper making in South Africa, or to convert them into "half stuff" locally, and ship the latter to Europe, as in this way a considerable saving would be effected in the cost of transport.

WILD SILK FROM MEXICO

In previous numbers of this Bulletin reference has been made to wild silks from Africa produced by species of *Anaphe* (1907, **5**, 438; 1910, **8**, 150; 1911, **9**, 412; 1912, **10**, 163). In August of last year a specimen of wild silk from Mexico, differing in character from Anaphe silk, was received at the Imperial Institute from Prof. Robert Wallace, of Edinburgh. According to information supplied with the material, the silk is found hanging on certain trees in the States of Vera Cruz and Oaxaca, and is obtainable in large quantities. It is stated that in Oaxaca the Indians use it for making rope. The sample forwarded was in the condition in which it is found in the forests, but, having been gathered a month after the rains had started, was somewhat discoloured.

The sample consisted of a portion of a flat, loosely spun, web-like nest, measuring 12 by 18 in., thin at the edges, with a thick central portion composed of several layers of silky fibre. The fibres seemed to run chiefly in one direction from one end of the nest to the other, but the

central part contained, besides these long fibres, a few very thin cocoons. A large quantity of sloughed caterpillar skins, dead caterpillars, leaves, excrement, bark, etc., was present, and one very thin complete cocoon contained a caterpillar, which was about 1 in. in length, and was covered with rather long brown hairs.

The material, when handled, was found to have an irritating effect on the more tender portions of the skin, probably owing to the caterpillar hairs, which were present among the silk.

On microscopic examination the silk was found to consist chiefly of single strands, but a few double strands were present. These double strands varied in diameter from 0·0005 in. to 0·0013 in.

A portion of the nest was cut off and freed as far as possible from extraneous matter by shaking and picking. By this means it was separated into web, 24 per cent., and extraneous matter, 76 per cent. The web was submitted to chemical examination with the following results :

	Per cent.
Moisture	12·1
Loss on degumming (expressed on the web dried at 100–110° C.):	
(1) After boiling 1½ hours in a 1 per cent. soap solution, washing with water, and drying at 100–110° C.	38 (approx.).
(2) After boiling one hour in a 3 per cent. soap solution, washing in water, and drying at 100–110° C.	33 (approx.).
(3) After boiling half an hour in a 3 per cent. sodium carbonate solution, washing in water, then boiling half an hour in a 3 per cent. soap solution, washing again in water, and finally drying at 100–110° C.	49 (approx.).

The degummed silk, which varied in colour from grey to greyish-brown, was of good lustre and fair strength, but it was difficult to comb out, and still contained many particles of extraneous matter, which were not easy to remove. The diameter of the clean fibres varied from 0·0002 to 0·00065 in., the average being 0·00035 in.

It was found that the use of sodium carbonate solution in degumming greatly weakened the fibre.

The silk contained in such nests as these could not be reeled, but would have to be carded and spun, and it is probable that the large amount of small fragments of

extraneous matter would render it very difficult to clean sufficiently for the carding and spinning to be satisfactorily accomplished. Moreover, the nests would yield only about 10 to 15 per cent. of clean degummed silk, and the irritating effect of the material on the skin must also be taken into account. It is therefore improbable that nests of the kind represented by the present sample would find a market among silk spinners.

The silk nest and specimens of the caterpillars were submitted to the Imperial Bureau of Entomology for determination. The Bureau reported that the larvæ are very similar to those of *Thaumatopœa processionea*, the European "Processionary Moth," and may be closely allied thereto, but that specimens of the actual moth would be necessary in order to identify the species.

KHAYA NYASICA TIMBER FROM MOZAMBIQUE

The *Khaya nyasica* timber which is the subject of this report was received at the Imperial Institute from the London Secretary of the Companhia de Moçambique in August 1913.

The sample consisted of a plank measuring 11 ft. by 2 ft. by 2 in., showing little sapwood on the edges, and well seasoned and uniformly sound throughout. The weight was 38 lb. per cubic foot.

The wood when freshly cut was pinkish-red with a brown tinge, but on exposure the colour improved to a deeper red-brown tint. It was uniform in texture, firm, moderately hard, and worked freely with both machine and hand tools. Cut and worked samples of the timber, when kept for about six weeks, showed no sign of warping.

Though coarser in the grain than the West African mahoganies, this timber took glue well, and could be used instead of mahogany for most commercial purposes, but it had not sufficient figure for use as a veneer wood. It polished well, and the tint, if in any way objectionable, could be modified in practice by an expert polisher.

The timber would be classed as a good average African mahogany, and if large logs could be shipped, as would seem possible judging by the present sample, this would be an important point in its favour.

A firm of timber brokers, who were consulted regarding the possible market for this wood, reported that it was of good quality, and so closely resembled mahogany that in their opinion there would be no difficulty in selling it as such. They added that many woods inferior to it are already being sold as mahogany.

The brokers stated that, if logs of good dimensions and in sound condition can be supplied, the wood should realise about 4*d.* to 4½*d.* per foot super, broker's sale measure, equivalent to say 2*s.* 9*d.* to 3*s.* 3*d.* per foot cube, actual measure; and they recommended that a trial shipment should be obtained for sale at auction in London.

CYMBOPOGON COLORATUS OIL FROM FIJI

The essential oils derived from certain species of Cymbopogon are well known in commerce as "lemon-grass" and "citronella" oils (this Bulletin, 1911, **9**, 240, 333). The former are derived mainly from *Cymbopogon flexuosus*, Stapf, and *C. citratus*, Stapf, and the latter mainly from *C. Nardus*, Rendle, var. "Lena-batu," in Ceylon, and from *C. Winterianus*, Jowitt, in Java. The chief constituent of the lemon-grass oils is citral, the proportion of which is usually between 70 and 80 per cent. The citronella oils, on the other hand, are characterised by the presence of considerable quantities of citronellal and geraniol, but contain very little or no citral.

In the course of a study of the various grass oils at the Imperial Institute, three interesting oils have been encountered which have not hitherto been described in detail, and which exhibit characters different from those of either the lemon-grass or citronella oils. One of these, derived from *C. polyneuros*, Stapf, grown in Ceylon, has a peculiar, sweet, penetrating odour, but has not been received in sufficient quantity for detailed investigation (this Bulletin, 1912, **10**, 29); it is hoped, however, that a

further quantity will be forwarded in due course. The second, *C. senaarensis*, Chiov. (*loc. cit.* p. 31), contains an aromatic ketone as its principal constituent, and is now being submitted to examination. The third new oil is furnished by the leaves of *C. coloratus*, Stapf, and contains considerable quantities of citral and geraniol, but no citronellal.

In 1907 seeds of a supposed lemon-grass were forwarded to Fiji from India, and the plant, since identified at the Royal Botanic Gardens, Kew, as *C. coloratus*, Stapf, has been grown at the Nasinu Experiment Station. The fresh leaves of this grass, when distilled with steam, are stated to yield about 0·35 per cent. of oil (*Bulletin* No. 6, 1913, *Dept. Agric., Fiji*). Samples of oil distilled in Fiji were forwarded to the Imperial Institute in 1908 and 1909, and were subjected to a preliminary examination (this BULLETIN, 1912, **10**, 27), and in 1912 a small consignment of the oil was received for sale. The oil was also examined by Umney (*Perf. and Ess. Oil Record*, 1912, **3**, 317), who found it to contain 35 per cent. of citral and 30 per cent. of geraniol.

It was clear from this preliminary work that, as pointed out in the report already published in this BULLETIN (*loc. cit.*), this oil showed characters common to both lemon-grass and citronella oils; it contained, for example, citral, which is the most important constituent of lemon-grass oils, and also geraniol, which is an important component of citronella oil, especially of the variety exported from Ceylon. As the oil is therefore of considerable scientific and commercial interest, it has been submitted to a detailed chemical examination with a view to supplementing the data already published regarding it.

The results thus obtained have been communicated to the Chemical Society of London by Dr. E. Goulding, F.I.C., and Mr. J. C. Earl, A.I.C., of the staff of the Scientific and Technical Department of the Imperial Institute (*Proc. Chem. Soc.*, 1914, **30**, 10). These results may be summarised as follows:

The principal odoriferous constituents of the oil are *citral*, which is present to the extent of 40 per cent., and

geraniol, which occurs in the free state to the amount of 23 per cent., and in the form of *geranyl acetate* to the extent of 10 per cent. There are also present about 7·5 per cent. of *terpenes*, among which l-*limonene* is probably included, and small amounts of free *acetic acid* and phenols; from the latter, a solid, tasteless, and odourless *phenol* was isolated. For technical details of the methods used in identifying and estimating these constituents, the original paper should be consulted.

The small consignment of this oil referred to above was sold in London in January 1913 at *2d.* per oz., with Cochin lemon-grass oil at 4¼*d.* per oz. and Ceylon citronella oil at 1*s.* 6½*d.* to 1*s.* 8*d.* per lb. The yield of this oil is, according to a statement in the Report on Agriculture, Fiji, for 1911, about 29 lb. per acre, which at the price quoted above for the oil is equivalent to a value of £3 17*s.* 6*d.* per acre.

FISH OILS AND GUANO FROM INDIA

The preparation of sardine oil and guano forms an important part of the experimental work of the Madras Government Fishery Department. Hitherto such work has been carried on at the Cannanore Experimental Station, but during 1911–12 it was transferred to the Experimental Station at Tanur, where fish are usually more abundant. At first crude brown oil only was prepared, but as there is a better market for the finer grades of fish oil, new machinery has been installed at Tanur for producing pale-coloured oil, for separating the "stearin," and for refining the oil, whilst deodorising experiments are also to be conducted there. The efforts of the Department to create a local fish-oil industry have been highly successful; in 1909 there was only one private factory, whilst at the beginning of the 1911–12 season between forty and fifty small factories were producing crude brown oil in Malabar and South Canara, and it seems probable that factories will also be started in Cochin and Travancore.

As the supply of fish along the coast fluctuates considerably, and the amount of oil in the fish varies in different

seasons, it is suggested that a large number of small factories is preferable to a small number of central factories. Attempts have also been made to devise methods suitable for use by single native families, in order to establish a kind of cottage industry.

In the small factories where crude brown oil is being produced the methods followed are of a simple kind. The fish are boiled in open pans, holding one-half or two-thirds of a ton, and the resulting mass is placed in coarse coir bags and pressed in simple screw presses. The pressed cakes of guano are broken up and placed on mats in the sun to dry. The crude oil is stated to fetch Rs. 160 (approximately £10 10s.) per ton of about 250 gallons at the factory, the middleman supplying the casks and bearing the cost of transport; the guano realises about Rs. 70 (approximately £4 10s.) per ton.

Several samples of the sardine oil and guano made in Madras have been received recently at the Imperial Institute from the Madras Government Fishery Department, and as the results of their examination are of general interest, they are now published.

Sardine Oil and Stearin

Seven samples of sardine oil and one sample of stearin obtained from sardine oil were received in August 1912. They were as follows:

1. "Palest oil from Cannanore."—A pale yellow oil, which deposited stearin on standing.

2. "Palest oil without stearin."—This was a bright yellow oil, clear when received at the Imperial Institute, but, like the other samples designated "oils without stearin" (Nos. 4 and 6), it deposited stearin to some extent at the temperatures commonly prevailing in Europe, viz. up to 20° C.

3. "Palest oil with stearin."—A yellow oil with a deposit of stearin.

4. "Yellow oil without stearin."—A pale brown oil.

5. "Yellow oil with stearin."—A pale brown, viscous oil.

6. "Brown oil without stearin."—Thick brown oil, possessing an unpleasant odour.

7. "Brown oil with stearin."—Dark brown semi-solid oil, possessing an unpleasant odour.

8. "Stearin."—Pale brown, soft fat.

The samples were examined with the results shown in the following table; No. 7 contained about 3·2 per cent. of water, which was removed before the constants were determined:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.
Specific gravity at $\frac{100^\circ C.}{15^\circ C.}$	0·878	0·877	0·877	0·877	0·876	0·876	0·875	0·874
Acid value[1]	3·7	2·3	1·8	4·7	7·1	35·0	53·5	9·0
Saponification value[1]	196	194	194	193	198	199	200	198
Iodine value . *per cent.*	154	156	157	159	154	157	157	131

[1] *Milligrams of potassium hydroxide per gram of oil.*

The general characters and constants of these sardine oils indicate their suitability for the usual purposes to which fish oils are applied, viz. leather dressing and currying, and to a smaller extent for soft soap manufacture, tempering steel, admixture with paint oils, and jute batching. The stearin would also be suitable for use in leather manufacture and soap making.

The various fish oils used in commerce (*e.g.* cod, herring, menhaden, Japanese sardine and shark liver oils) differ a good deal from one another in physical and chemical characteristics, but they all have a high iodine value. This constant is of great importance, as it indicates the readiness with which an oil will undergo oxidation, a property on which the value of an oil for leather dressing largely depends.

The principal fish oil used in the leather industry of the United Kingdom is cod oil, commercial specimens of which usually have an iodine value of about 155. It will be noticed that the iodine values of these sardine oils from Madras (viz. 154 to 159) approximate very closely to this figure.

With the exception of the brown oils (Nos. 6 and 7), all

the samples had low acid values and appeared to have been carefully prepared. The somewhat high acid values of the brown oils would reduce their value for leather dressing, as such oils are usually regarded as unsatisfactory for this purpose.

Two further samples of fish oil were submitted for examination, in February 1913.

No. 9. "Brown oil with stearin."

No. 10. "Brown oil without stearin."

These oils were dark brown in colour and had a very unpleasant odour. They were filtered, and then chemically examined with the following results:

	Brown oil with stearin.	Brown oil without stearin.
Specific gravity at $\frac{100° C.}{15{\cdot}5° C.}$	0·881	0·879
Acid value	12·1	11·8
Saponification value (approx.)	200·2	200·0
Iodine value *per cent.*	155·2	154·1

The constants of these two oils correspond on the whole with those of the previous samples.

The present specimens have much lower acid values than the two samples of brown oil (Nos. 6 and 7) then dealt with, but they were darker in colour and their odour was still more unpleasant.

The remarks made above as to the uses of the oils are also applicable to the present samples.

Fish Guano

The following samples of fish guano were received along with samples Nos. 9 and 10 above:

No. 1. "Fish guano prepared at the Government Fisheries Station, South Malabar."

No. 2. "Fish guano prepared at the Government Experimental Station at Tanur, South Malabar": (a) "Ordinary guano," (b) "Guano from large oily sardine."

The guanos consisted of fragments of the bones, flesh, and scales of small fish. They were examined with the following results:

	No. 1.	No. 2a.	No. 2b.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	7·86	8·82	8·68
Crude proteins	49·22	53·65	56·40
Consisting of:			
True proteins	43·75	45·41	49·06
Other nitrogenous substances	5·47	8·24	7·34
Fat	6·69	5·38	8·52
Other organic matter	7·37	4·73	5·01
Ash	28·86	27·42	21·39
The ash contained:			
Lime CaO	33·10	42·32	42·12
Potash K_2O	0·85	2·17	2·19
Phosphoric anhydride P_2O_5	29·52	35·32	35·56

The following table shows the percentages of lime, nitrogen, phosphoric anhydride, fat and water present in these three samples of fish guano from South Malabar, compared with the corresponding figures recorded for fish manure from other sources:

	Lime. CaO.	Nitrogen. N.	Phosphoric anhydride. P_2O_5	Fat.	Water.
No. 1	9·6	7·8	8·5	6·69	7·86
No. 2a	11·6	8·6	9·7	5·38	8·82
No. 2b	9·0	9·0	7·6	8·52	8·68
Fish manure from refuse (United Kingdom)	—	7·8	8·1	—	18·9
Dried menhaden scrap (U.S.A.)	—	8·0	8·5	—	Not exceeding 12·0
Norwegian cod heads and bones	—	8·0	14·9	—	13·0
Norwegian whale manure	16·5	7·6	13·4	—	5·3
Dried codfish skins and bones	—	8 to 9	10 to 12	—	5 to 6
Canadian dogfish scrap	—	8·8	7·7	16·6	5·5
Brittany fish manure	—	6·5	13·1	—	5·0

The commercial fish meal sold in Europe as food for cattle and pigs contains the following proportions of the most important constituents:

	Proteins.	Phosphoric anhydride.	Fat.
	Per cent.	*Per cent.*	*Per cent.*
English meal from fish refuse	50 to 65	6·6 to 8·5	3 to 6
Norwegian codling meal	50 to 60	11·3 to 13·1	1 to 2
Herring meal	60 to 70	3·7 to 4·7	10 to 12

A comparison of the figures given in the table above for well-known commercial fish manures with those recorded for the present samples of fish guano from South

Malabar shows that the latter contain about the same percentage of nitrogen as the other manures and an average amount of phosphoric anhydride, and there is therefore no doubt that they would be readily saleable as fish manures.

These Indian fish guanos are not quite so rich in proteins as the fish meals mentioned in the table on p. 54. They contain, however, average quantities of phosphoric anhydride and fat, and would no doubt be readily saleable for the preparation of feeding-stuffs of the fish-meal type, provided they are prepared from fresh fish and are kept in good condition.

THE COMPOSITION OF MONAZITE

In previous issues of this Bulletin (1905, **3**, 151, 285), detailed accounts have been given of the occurrence, distribution, and uses of thorium minerals. Of these minerals the most important from an industrial point of view is monazite, which is the source of most of the thoria used in the manufacture of incandescent gas mantles, and has acquired further importance recently as a source of the radio-active substance, mesothorium. (For an account of the utilisation of the rare earths other than thoria present in monazite, see this Bulletin, p. 110).

A large proportion of the monazite used industrially is obtained from deposits in Brazil, the quantity of sand containing 90 per cent. of monazite exported during 1912 being 3,398 metric tons. The most extensively worked deposits in Brazil are the naturally concentrated sands on certain parts of the sea coast, and the monazite separated from these contains on the average from 5·0 to 7·0 per cent. of thoria. The less important deposits inland yield monazite containing from 4·0 to 5·7 per cent. of thoria.

During the past two years an important contribution to the world's production of monazite sand has been made by the Native State of Travancore in India. The output in 1911 amounted to 811 tons, valued at £24,044, and in 1912 this had increased to 1,135 tons, valued at £41,419.

In the course of the Mineral Surveys conducted in connection with the Imperial Institute in recent years in Ceylon, Southern Nigeria, Northern Nigeria, and Nyasa-

land, many concentrates have been obtained which proved to contain monazite. This mineral had not previously been recorded from these countries, and particulars of the occurrences will be found in the official reports of these Surveys, which are published periodically in the Miscellaneous Series of Colonial Reports (London: Messrs. Wyman and Sons). Similar concentrates have also been received at the Imperial Institute from Travancore and Malaya.

The materials received at the Imperial Institute have been mostly in the form of sands already concentrated by washing. They contained numerous minerals other than monazite, and in such cases the monazites were separated from the concentrates by electro-magnetic or electrostatic means. In a few cases, the monazite examined consisted of a single fragment weighing several grams.

Complete analyses of monazites from all these sources have been made in the Scientific and Technical Department of the Imperial Institute, and the results have been communicated recently by Mr. S. J. Johnstone, B.Sc., of that Department, to the Society of Chemical Industry (*Journ. Soc. Chem. Indust.* 1914, **33**, 55). For information as to the methods of analysis used and other details the original paper should be referred to, as only a summary of the results obtained can be given here.

Monazite from Ceylon

		1. Monazite pebble from Naminkanda, Morawak Korle.	2. Monazite pebble from Muladiwanella Durayakanda, Gilimale.	3. Sand from Niriella-ganga.	4. Monazite pebble from Ratna-pura.	5. Monazite pebble from Ratna-pura.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Thoria	ThO_2	9·75	9·49	10·75	10·29	28·20
Ceria	Ce_2O_3	27·51	27·15	26·71	27·37	20·65
Lanthana and allied oxides	La_2O_3, etc.	29·59	29·59	30·06	30·13	21·63
Yttria and allied oxides	Y_2O_3, etc.	2·54	3·93	1·46	2·14	0·94
Ferric oxide	Fe_2O_3	1·27	0·87	1·09	0·81	1·13
Alumina	Al_2O_3	0·61	0·17	0·70	0·17	0·29
Lime	CaO	—	0·45	0·85	0·41	0·10
Silica	SiO_2	1·78	1·67	2·47	1·03	6·09
Phosphoric anhydride	P_2O_5	26·12	26·12	24·61	27·67	20·20
Loss on ignition		0·59	0·48	0·93	0·20	—
Specific gravity		5·20	5·25	—	5·23	5·47

From these results and numerous partial analyses made at the Imperial Institute, it is evident that the Ceylon monazite usually contains about 10 per cent. of thoria, which is nearly double the amount found in the monazite of Brazil. It must be mentioned, however, that as little as 5 per cent. of thoria has been found in certain monazite sands from Ceylon, but material of this character appears to be of somewhat infrequent occurrence. Occasionally, specimens are met with having an unusually high specific gravity and a correspondingly high percentage of thoria, which it will be seen has reached over 28 per cent. (column 5 in table). The Ceylon monazite in general is very similar in composition to one of the Norwegian varieties, the analysis of which is given on p. 60.

Monazite from Travancore

Two specimens of this monazite gave the following results:

		No. 1. Per cent.	No. 2.[1] Per cent.
Thoria	ThO_2	10·22	8·65
Ceria	Ce_2O_3	31·90	61·11
Lanthana and allied oxides	La_2O_3, etc.	28·00	
Yttria and allied oxides	Y_2O_3, etc.	0·46	0·62
Ferric oxide	Fe_2O_3	1·50	1·09
Alumina	Al_2O_3	0·17	0·12
Lime	CaO	0·20	0·13
Silica	SiO_2	0·90	1·00
Phosphoric anhydride	P_2O_5	26·82	26·50
Loss on ignition		0·46	0·45

[1] *Isolated from a concentrate supplied by the State Geologist, Northern Division, Travancore.*

These analyses show that the monazite of Travancore contains a high percentage of thoria, approaching that of ordinary Ceylon monazite. According to E. White (*Thorium and its Compounds*, p. 10), up to 14 per cent. of thoria has been found in Travancore monazite.

Monazite from Malaya

Monazite sand has been found in many localities in the Federated Malay States and the protected States of Kedah

and Kelantan in association with alluvial tinstone (this BULLETIN, 1906, **4**, 301; 1911, **9**, 99).

The following are the results of analysis of samples of typical monazites from this source:

		Locality.	No. 1.[1] Puchong Babi, River Kenring, Perak.	No. 2.[1] Kulim, Kedah.	No. 3. Kelantan.
			Per cent.	*Per cent.*	*Per cent.*
Thoria	ThO_2	. .	3·40	3·53	9·41
Ceria	Ce_2O_3	. .	33·74	64·05	60·00
Lanthana and allied oxides	La_2O_3, etc.	.	32·53		
Yttria and allied oxides	Y_2O_3, etc.	.	0·91	2·40	2·82
Ferric oxide	Fe_2O_3	. .	0·65	0·64	1·13
Alumina	Al_2O_3	. .	0·03	0·07	
Lime	CaO	. .	0·33	0·17	0·29
Silica	SiO_2	. .	1·45	1·08	2·20
Phosphoric anhydride	P_2O_5	. .	26·58	27·87	23·71
Loss on ignition	. . .	. .	0·94	0·52	0·94

[1] *Isolated from concentrates supplied by the Geologist to the Federated Malay States Government.*

These figures show that there are wide variations in the percentage of thoria in monazite from Malaya, from the Perak specimen, containing only 3·4 per cent., to that from Kelantan, which contained over 9 per cent., and is superior in this respect to the average Brazilian material.

Monazite from Nyasaland

The following are the results of an analysis of monazite separated from a concentrate obtained from a stream at Namalundo Hill, near Chiromo in the Nyasaland Protectorate.

			Per cent.
Thoria	ThO_2	. .	7·10
Ceria	Ce_2O_3	. .	32·52
Lanthana and allied oxides	La_2O_3, etc.	.	26·91
Yttria and allied oxides	Y_2O_3, etc.	.	1·50
Ferric oxide	Fe_2O_3	. .	1·10
Alumina	Al_2O_3	. .	0·20
Lime	CaO	. .	0·32
Silica	SiO_2	. .	1·66
Phosphoric anhydride	P_2O_5	. .	28·16
Loss on ignition	. . . .	. .	0·25

From the results of numerous partial analyses made at the Imperial Institute on other samples of monazite from Nyasaland, it would appear that the average thoria content is about 6 per cent.

Monazites from Nigeria

		Northern Nigeria.			Southern Nigeria.		
Number		1.	2.	3.	4.	5.	6.
Locality		Ekole.	Kadera, Central Province.	Jarawa river, Naraguta.	Iboboto stream, Nsan-Oban track.	Between Iboboto stream and Ebara river.	Ebara river.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Thoria	ThO_2 .	5·00	3·20	8·00	6·19	2·30	5·50
Ceria	Ce_2O_3 .	30·72	36·53	30·50	30·38	34·58	31·40
Lanthana and allied oxides	La_2O_3, etc.	30·02	30·00	28·80	29·60	29·83	29·20
Yttria and allied oxides	Y_2O_3, etc.	2·74	0·39	1·43	1·33	1·29	2·00
Ferric oxide	Fe_2O_3 .	3·00	1·20	0·81	1·50	1·80	0·75
Alumina	Al_2O_3 .	0·35	0·10	0·20	0·10	—	0·05
Lime	CaO .	0·15	0·21	0·17	0·16	0·19	0·10
Silica	SiO_2 .	1·20	0·63	1·79	0·85	0·73	0·82
Phosphoric anhydride	P_2O_5 .	26·29	28·29	28·16	29·70	29·71	29·92
Loss on ignition	. .	0·25	0·20	0·21	0·33	0·21	0·44

It would appear from analyses Nos. 4, 5, and 6 above, that monazite from different parts of the same locality, and apparently derived from the same source, may contain widely different percentages of thoria, but further work is necessary to confirm this point, which is of considerable commercial and scientific importance. The above results show that the percentage of thoria in monazite from Nigeria may vary between fairly wide limits. The average thoria content of a large number of Nigerian monazites examined is 5·5 per cent. for those from Northern Nigeria, and 5·8 per cent. for those from Southern Nigeria. The results show that these monazites, as a whole, are nearly as rich in thoria as those exported from Brazil.

For comparison with the foregoing results the following analyses of monazites from other sources may be given.

		1. Brazil.		2. United States.		3. Canada.	4. Australia.	5. S. Norway.
		Espirito Santo.	Alcobaca, Bahia.	Amelia County, Virginia.	Burke County, North Carolina.	Ottawa, County Quebec.	Emmaville, New South Wales.	—
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Thoria	ThO_2 .	6·06	6·50	14·23	6·49	12·60	1·23	9·34
Ceria	Ce_2O_3 .	62·12	61·40	29·89	31·38	24·84	36·64	28·06
Lanthana and allied oxides	La_2O_3, etc. .			26·66	30·88	26·41	30·21	29·60
Yttria and allied oxides	Y_2O_3, etc. .	0·80	0·70	—	—	4·76	—	1·82
Ferric oxide	Fe_2O_3 .	0·97	1·50	—	—	1·07	—	0·66
Alumina	Al_2O_3 .	0·10	0·08	—	—	—	3·11	0·16
Lime	CaO .	0·21	0·30	—	—	1·54	—	0·53
Silica	SiO_2 .	0·75	0·64	2·85	1·40	0·91	3·21	1·65
Phosphoric anhydride	P_2O_5 .	28·50	28·46	26·12	29·28	26·86	25·09	28·27
Loss on ignition	.	0·38	0·64	0·67	0·20	0·78	—	0·21

SPECIAL ARTICLE

AGRICULTURE IN THE BELGIAN CONGO

By E. Leplae

Director-General of Agriculture, Colonial Office, Brussels

The total area of the Belgian Congo amounts to about 909,654 square miles, with a native population estimated at 10,000,000. The terrible disease, "sleeping sickness," has made great ravages in many districts, but the situation is improving, thanks to the measures taken by the State during the last few years.

Native Agriculture

With few exceptions, the native tribes follow agriculture, the clearing of the land being done by the men, while the planting and care of the crops is left to the women. The central part of the Congo is covered by vast equatorial forest, where the rainfall is fairly evenly distributed over the twelve months of the year. The principal food crops in this zone are manioc (cassava) and bananas, to which may be added maize, sugar-cane, sweet-potatoes, and various crops of minor importance. The oil-palm affords an important part of the food supply

in a large part of this district. It is difficult to raise cattle with success in the forest region, and the natives do not attempt it; they have, however, goats, sheep, fowls, pigeons, and Barbary ducks.

The equatorial forest is surrounded by a wide belt of savannahs, which run along the frontiers of the State, covering the Lower and the Middle Congo, Kasai, Katanga, the region of the Great Lakes, and the east of Uele. The cereal crops in this region are numerous and important. The natives plant sorghum, maize, millet, eleusine, pea-nuts (ground nuts), haricots, and sesamum; manioc and plantains are also generally cultivated, except in the highest parts, where these plants ripen too slowly. In certain districts cattle are kept, and small cattle and poultry are reared in all parts.

The natives cultivate numerous varieties of each of the plants included in their usual crops. The study of these varieties has now been commenced by the Agricultural Department, and promises to be highly interesting. In the Bokala region alone, an agent collected fifteen sorts of manioc from the native crops, whilst another discovered twenty-two kinds of plantain trees in Mayumbe.

The origin of the plants in the native plantations often goes back to importations made by foreign traders. The Portuguese, coming from Angola, introduced certain varieties of cotton; the Arabs imported from Zanzibar fifty years ago, wheat, rice, cotton, and several fruit trees. Numerous species and new varieties are being introduced now at the State agricultural stations, and in those maintained by the missions; they come from foreign colonies, and especially from the British and Dutch East Indies, and will be distributed among the agricultural population. The State also distributes to the natives of certain districts cattle, goats, and sheep.

The growth of important towns such as Boma, Leopoldville, and Stanleyville, and the assemblage of large bodies of labourers for railway construction and the working of the mines, have opened remunerative markets to the natives for the sale of food-stuffs, with the result that a notable extension of certain crops has taken place,

especially that of rice. In many parts the same is true for European vegetables, and certain tribes (*e.g.* the Marungu) have even adopted the regular cultivation of potatoes and wheat.

Native agriculture is, incontestably, progressing in the whole territory, and the State is doing its best to find new means of developing it. Great progress will be made if it is possible to persuade the natives to add, to their actual food crops, small plantations of commercial and industrial products, such as rubber-, fibre- and oil-yielding plants, coffee, cocoa, kola, etc. This question has been very much to the fore since the fall in the price of rubber seriously affected the commercial companies established in the Belgian Congo, and various proposals have been made to develop the agricultural production of the natives in a commercial way. The companies can themselves contribute powerfully towards this end by obliging their agents to buy the produce cultivated by the natives, instead of, as they have done up to now, only buying rubber, copal, and ivory. Important markets could thus be created for peanuts, palm-oil, cotton, coffee, cocoa, etc., provided that the transport rates towards the coast and the factories are sufficiently reduced. This reduction is actually being considered. The State can intervene very efficaciously, not only by reducing the transport rates, making roads, devising suitable measures for creating markets, and distributing seeds and plants; but also by buying from the natives the different products for which it would be difficult to find a sale at first. Instead of trying persuasion alone, the State might oblige the natives to cultivate certain crops that they could sell for their own exclusive profit. It could, for instance, replace the payment of taxes, during a certain number of years, by the obligation to plant a certain number of trees or a certain area. Such compulsory planting is attracting much attention at the present time, because it would have the undoubted advantage of rapidly creating a native landed interest and capital.

Similar measures have been adopted in some foreign colonies. In the Samoan Islands the German Government has since 1900 imposed, on each male adult, the obligation

to plant and maintain fifty coconut trees. In this way the native production of copra has been quadrupled, and the natives themselves have thoroughly understood that it is to their own interest to submit to the Government measures. The area planted is increasing, and surpasses the minimum required by the law, whilst the number of infractions of this regulation is decreasing from year to year. Analogous regulations have been suggested for the Belgian Congo. To each adult native would be allotted sufficient land to produce his food-crops (manioc, rice, maize, peanuts, etc.), and also a certain number of trees or plants, yielding a commercial product, which would be, according to the locality, rubber, coffee, cocoa, oil-palm, coconuts, cotton, etc. The native would be exempted from payment of taxes during the number of years necessary for the establishment of these plantations, which would be compulsory and would be rigidly controlled by special agents, whose duties would be to determine the conditions of planting, to verify the state of the crops, etc. When the plantations commenced to yield, the native would have to pay taxes as before, and the land under cultivation would become his property, the entire crop belonging to him. Special laws would forbid the sale of these plantations to Europeans, or their appropriation by a third party.

The result of this system would be, after a few years, to give to a large number of natives an appreciable revenue and to rapidly increase the production of the Colony, and, at the same time, to enrich the public treasury by the duties levied on exports.

By applying this measure to the production of Para rubber, for instance, each native would have to plant one hundred trees in five years. After ten years, at the rate of 600 grams of dry rubber per tree, the yield of the plantation would be 60 kilograms per annum, worth 2*s.* per kilogram, equal to a sum of £6. If 500,000 natives, one tenth of the tax-payers, were compelled to make these plantations, the annual crop would be worth £3,000,000.

Real advantages would therefore follow on compulsory planting—it would supply a fairly simple means of overcoming the apathy and heedlessness of the blacks, it would

assure the livelihood and permanence of the population, and it would promote trade and provide the State with taxable commodities.

Put in force in the populous regions, inhabited by active agricultural tribes, compulsory planting would very rapidly create an intense commercial development. This would be especially the case in the Kasai district, where the villages often count from 1,000 to 5,000 inhabitants, all agriculturists.

There appears to be little doubt that the natives would understand readily the advantages resulting to each of them from the possession of a well-established plantation, kept up almost without any expense.

A careful selection ought to be made, of course, between the numerous trees and plants that could be raised by natives. Crops that grow and yield with very little trouble and labour would be the most suitable. For instance, Funtumia, close planted and tapped three times only in a year, would probably do better than Hevea, unless the latter could be tapped in a very simple manner, similar to Brazilian tapping.

State Breeding Stations

Experiments relative to cattle-breeding are being made at the following stations:

Zambi (Lower Congo).—Founded in 1895, this station, situated 24 miles from Boma, on an arm of the river, is principally used as a quarantine station and for the purpose of acclimatising animals imported from Europe and foreign colonies. Seventy-two horses, 73 donkeys, 4 mules, 129 native cattle, 33 Belgian cattle, 12 cattle from Dahomey, 20 zebus from South India, 1 buffalo, and 38 pigs are being maintained here. One hundred and twenty-five acres of pasture have been created from which the tsetse fly has disappeared. A laboratory for veterinary experiments has been added to this station, which also possesses a laboratory for soil analysis. The staff includes two veterinary surgeons, a chemist, and three agricultural agents.

Kitobola (Lower Congo).—This station, founded in 1898, possesses an irrigating plant and its fertile lands are

in regular culture, producing cereals, and fodder for the farm animals. The herd comprises 120 cattle, 2 horses, and 4 pigs. The work of clearing the jungle, commenced in 1913, has for its object the elimination of the tsetse fly from the pastures. The staff comprises three European agents and 200 natives.

Dolo.—This station, situated 5 miles from Leopoldville, has 216 cattle, 20 donkeys, and 52 sheep and goats. A veterinary surgeon is quartered here. The farm is under the direction of two agents, who supervise the work of 100 natives.

Tshopo (Stanleyville).—This farm has 78 head of cattle and 33 sheep.

Nyangwe (Maniema).—This station was founded in 1900. The herd is composed of 533 cattle, 2 horses, 52 donkeys, and 20 sheep.

Miao (Kasai).—Founded in 1912, this farm keeps the State herds which were formerly at Lusambo and Luluabourg. There are 459 head of cattle, 6 horses, 12 donkeys, 1 mule, 110 sheep, and 28 goats. A veterinary surgeon and an agricultural agent are attached to this station, with 100 native workmen.

Kateniania (Katanga).—This post, founded in 1912, is established on the high tableland of the Biano Hills; as annexes it has the posts of Mufumai and Kimbundji. The herd is composed of 491 cattle of Barotse breed, 55 sheep and goats, and 11 pigs. The staff includes a veterinary surgeon and three agents.

Ditunguru and Mutambala (Katanga).—Established in 1911 on the tableland of the Kundelungus, near Lake Moero, the station at Ditunguru has received the herd from the old post at Lukonzolwa and maintains 108 head of cattle and 90 sheep and goats. The neighbouring post at Mutambala in Marungu, near Lake Tanganyika, has a small herd consisting of 74 head of cattle.

Api and Ango (Uele).—These stations are for taming elephants. The Api station was founded in 1900. With a branch at Ango, it maintains 33 African elephants of different ages. The staff is composed of two European agents and 60 blacks.

The results of the principal investigations accomplished at these State Breeding Stations on the different species of domestic animals may be summed up as follows:

1. *Tsetse Fly.*—In the whole of the forest region and in the greater part of the savannahs, the danger of infection from tsetse fly is permanent. Great care must be exercised in choosing situations for cattle-breeding stations and the jungle must be thoroughly cleared in the neighbourhood of the pastures, and especially along the banks of rivers and streams. This clearing of the jungle is very efficacious, and almost completely removes the tsetse fly.

2. *Feeding.*—The better the feeding the less susceptible are the animals to sickness, and especially to the attack of the tsetse fly. The establishment of a breeding station ought to be accompanied by the creation of pastures and the cultivation of fodder, assuring the proper alimentation of the animals at every period of the year. The natural pastures of the savannahs can be rapidly improved by removing the bushes, repeatedly mowing the grass, and by sowing fodder-producing seeds. In certain years the abnormal dryness is very harmful to the animals; it is therefore necessary to have recourse to irrigation for the fodder, or the pastures should be situated on land which retains sufficient moisture even at the end of the dry season.

3. *Horses.*—Horses are useful, especially for riding and driving purposes, and may also be used for the production of mules. Several breeds of horses have been imported into the Belgian Congo. The small breeds or ponies become acclimatised most rapidly, more especially the "Cayor" and "Bayar" (Senegal) breeds, which, without difficulty, support the great heat of the Lower Congo. The State has just bought from Java and sent to the Zambi station a few ponies of the Sandelwood breed. Coming from a hot and damp climate, these horses will probably adapt themselves to the climatic conditions of Central Congo.

4. *Donkeys and Mules.*—The small grey Senegal donkeys have shown the greatest resistance to the climate of the Lower Congo, and breed there without difficulty. The tall donkeys from Italy and France do not stand the heat so well, but apparently their breeding ought to be

successful. The mule-breeding experiments are still incomplete.

5. *Angola Cattle.*—These animals are raised at the State stations and at the missions in the Lower Congo. They breed normally, except during the exceptionally dry years, but they give hardly any milk, and fatten slowly. They can be rapidly improved by crossing with European cattle. The crosses obtained at Zambi, Kitobola, and Dolo, show a good milk production and furnish meat that is already quite satisfactory, but the infusion of European blood must not be pushed too far, or the capacity of the cattle to stand the heat will be diminished, and large cattle, for which it will be difficult to produce enough fodder, will be produced.

6. *Barotse Cattle.*—The high and grassy tablelands of Katanga are free from tsetse fly and suitable for breeding cattle. A herd of a few hundred Barotse cows has been introduced from Northern Rhodesia. They will be crossed with English bulls bought at Livingstone.

7. *Uele Cattle.*—In this province fairly large cattle of the Dinka and Waday breeds from the Nile are most numerous. They have been introduced at different periods as far as the centre of the colony. The former are fairly good milk producers. The small Lugwaret breed, from 3 ft. 8 in. to 4 ft. high, is the real native breed of North-Eastern Congo.

8. *Kivu Cattle.*—The natives of the mountainous regions of Kivu raise many cattle, partly belonging to the German West African breeds. Some are without horns, others with short or long horns. The small hornless breed is distinguished for its qualities as a milk yielder and the ease with which it is fattened, but it is rather scarce. The short-horned race is a little larger; it is also a good milk producer. The long-horned breed, 4 ft. 8 in. in height, gives little milk, and is difficult to fatten. The breeding stations founded by the State in the Kivu region have not been maintained, as the natives are careful cattle breeders. Every family has a few head of cattle, and the cattle sleep in the native huts. The action of the Government will be limited to the introduction of cattle for the improvement of the local breeds.

9. *European Cattle.*—A certain number of Belgian bulls have been sent to Zambi to be crossed with the native Angola cattle. These animals, fed in the stable and grazing every day, generally stand the climate of the Lower Congo for several years. The results obtained to date show a very perceptible improvement as regards both the meat- and the milk-producing qualities. Belgian cows were also sent with the object of producing animals of pure Belgian breed in Africa itself for the improvement of the local cattle.

Some milch cows of the small black and white Brittany breed were imported from France in 1912, and the raising of these on the Zambi pastures has continued till now in a satisfactory manner. These small and frugal cows give very satisfactory results as milk producers.

10. *Dahomey Cattle.*—The French colony of Dahomey produces a breed of very small cattle, of no milking value, but suitable for meat production. Trials with this breed are in progress at Zambi.

11. *Indian Zebus.*—Ten cows and two bulls belonging to the white Nellore breed were bought in India and located at Zambi, where they are now well acclimatised. Calves are numerous and are in good condition. The zebu will be able to render great services as a draught and pack animal.

12. *Italian Buffaloes.*—The domestication of Congo buffaloes has not yet been undertaken, although these animals are very numerous, and in some parts herds of from two to three hundred head are to be found. Italian buffaloes were imported in 1911, but the greater number died soon after their arrival, probably owing to an attack of "barbone" (*septicæmia hæmorrhagica*). One cow remains, and for the last two years has been in excellent condition.

13. *European Goats, Sheep, and Pigs.*—Some European milch goats have been introduced into the Lower Congo and sent to the interior for the purpose of improving the local breeds, which generally give very little milk.

14. *Pigs.*—The breeding of European pigs has been undertaken at Zambi, and has given encouraging results.

15. *Poultry.*—The native fowl is very small but very hardy. Several European breeds are being used for the improvement of the local poultry, with the object of obtaining cross-bred fowls of medium size. Certain of the stations are provided with incubators.

16. *African Elephants.*—The domestication of the African elephant has been under trial since 1901 at the Api post (Uele), under the direction of Commandant Laplume. The herd actually numbers thirty-three tame elephants, of which the greater number are quite docile and can be harnessed to ploughs and vehicles. The oldest of them are in regular work.

17. *Zebras.*—A herd of ninety zebras was captured in Katanga in 1914 and underwent taming and training. It was possible to break in several zebras for riding purposes, but the mortality was very high, and several accidents caused the enterprise to be abandoned.

The Veterinary Service.—There are at the present time fourteen veterinary surgeons in the Belgian Congo, of whom four are in Katanga. The duties of these officers are to see to the observance of the regulations relating to the health of domestic animals, to inspect slaughter-houses and meat markets, to study and improve native methods of cattle breeding, to treat animals that are ill in the State breeding stations as well as those belonging to private persons, and, finally, to assist in the scientific researches made at the veterinary laboratory at Zambi by collecting material for study.

The Distribution of Cattle to the Missions and to Private Persons.—The greater number of the missions undertake the breeding of large or small cattle. Some of the mission herds are very important; thus the Jesuits' missions at Kisantu and its neighbourhood maintain upwards of 800 head of cattle.

The State does its best to encourage these enterprises by placing at the disposal of the missions and of private owners animals of good breeds. According to the present regulations, the males are given gratuitously, while the females are lent under the condition that the original number must be returned at the end of five years.

Experimental Farms

The following agricultural stations are devoted to experimental cultivation:

Botanical Garden at Eala (Equator).—Founded in 1900, the Eala botanical garden is situated on the Equator, in a hot and damp climate, which represents the average climate of the forest region. The average annual rainfall is 80 in., fairly regularly distributed over the twelve months of the year, with two rather drier periods, one about January, the other about July.

The temperature is remarkably constant; the average minimum temperature is 68° F. and the average maximum 86° F. The average temperature for the whole year is 77° F.

The Eala botanical garden is provided with varied and interesting plantations. The botanical collection comprises upwards of 1,200 species and varieties, of which 600 belong to the flora of the Congo. The economic collections occupy about 200 plots of land, and include the most important varieties of cultivated tropical plants, including rubber, gutta-percha, and balata; copal; coffee, cocoa, tea; plants yielding essential oils; tinctorial plants; tanning, medicinal, and aromatic plants; textile and oil-seed-yielding plants; fruit trees; alimentary and fodder plants.

Quantities of seeds and of plants of economic or ornamental value are sent from the Eala botanical gardens to the agricultural stations and posts in the Colony, also to the missions and to private individuals. Exchanges with foreign botanical gardens are regularly made.

The Eala garden has now been placed under the control of Dr. Vermoesen, Director of the mycological service and of the laboratory for plant diseases. The laboratory for applied entomology has lately been transferred to Eala.

The staff of the station comprises four European agents, controlling 300 natives.

Bakusu Station (Coquilhatville, Equator).—About 150 acres (12,000 trees) are planted with *Hevea brasiliensis*, and 80 acres (20,000 trees) with *Funtumia elastica*. These plantations are employed especially for tapping experiments.

and for the production of seed for the other stations of the Colony.

Congo da Lemba (Lower Congo).—This station, situated 6 miles from the 40-kilometre post, on the Matadi railway, is one of the oldest in the Congo, and was at first reserved for the cultivation of coffee. It possesses specimens of many economic trees, 10 to 12 years of age. It is now used mainly for forming collections for the study of coffee, cocoa, fruit trees, and various industrial and commercial plants, to be distributed amongst the colonists and to the State agricultural stations. This station is especially rich in species and varieties of fruit trees from foreign colonies. A small flock of sheep is also kept here.

Barumbu Station (Aruwimi District).—This is principally reserved for the cultivation of cocoa (280 acres with 69,889 trees) and *F. elastica* (345 acres with 96,827 trees). The Barumbu station also includes a few old plantations of rubber vines and coffee, and a small number of Hevea trees. It is under the direction of a European agent with 200 native workmen.

Cocoa plantations succeed very well here, the soil being excellent; two-thirds of the trees are productive, and yielded in 1912 a crop of 30 tons of dry cocoa. There are some interesting plantations of cocoa interplanted with oil-palms.

Kitobola Station (Lower Congo).—Situated on the river Lukuga, 9 miles from the station of Tumba, the Kitobola farm comprises 318 acres of excellent land, the greater part being irrigated, of which 285 acres are devoted to alimentary and experimental crops, and 33 acres to rubber and lime trees. The land was allocated as follows in 1913:

	Acres.		Acres.
Dry rice	45	Sweet-potatoes	40
Irrigated rice	43	Sugar-cane	11
Ceylon rice	4½	Manioc	2½
Java rice	7⅓	Cotton	5½
Maize	30	Flax	2
Fodder	14		

Comparison of American, Egyptian, and Indian cottons was started at Kitobola in 1913 under the supervision of an expert recommended by the British Cotton Growing Association; 50 acres are devoted to this experiment.

Coconut trees ($2\frac{1}{2}$ acres), oil-palm (5 acres), pea-nuts, castor-oil, sesamum, and jute plantations have been established this year.

The farm has extensive pastures, and, as already mentioned, maintains a large herd of cattle. The staff comprises four Europeans and 200 natives.

Owing to the fertility of the soil, the facilities for irrigation, and the possibilities of cattle breeding, the Kitobola experimental station is of great practical interest.

Ganda-Sundi Station (Mayumbe, Lower Congo).—Originally destined entirely for rubber plantations, this station has, since 1912, given considerable attention to the planting of cocoa. At the end of 1913, 1,050 acres were planted with *Funtumia elastica*, 50 acres with Hevea, and 350 acres with cocoa.

Munama Experimental Station (Katanga).—Founded in 1912, this station is situated 9 miles from Elisabethville. It was equipped in 1913 for the study of the varieties and the conditions of cultivation, of agricultural plants suited to the climate of the high lands of Katanga. It also undertakes the raising of poultry of different races in incubators, and maintains experimental hives of European and native bees. The following special work is in progress:

1. Investigation of the species and varieties of agricultural crops best adapted to local conditions. At present 28 varieties of maize, 11 of wheat, 5 of oats, 4 of barley, 3 of rice, 6 of sorghum, 8 of millet, 10 of tobacco, 12 of potatoes, 12 of beans, etc., altogether 181 varieties of 60 different plants, and 69 varieties of 19 kinds of fruit trees, are being tried and studied comparatively.

2. The study of crop rotations, chemical manures, fallows, and green manures.

3. The relations of the plant to the soil.

4. Comparison of different times of sowing and planting.

5. Determination of the best spacings for the principal agricultural plants.

6. Selection of various plants.

7. Formulæ for the sowing of permanent pastures.

8. Field trials.

The experimental station covers 70 acres of ground,

situated along the river Munama. The staff comprises a director, with two European agents, and 100 native workmen.

INTRODUCTION OF NEW ECONOMIC PLANTS.—The introduction into the Belgian Congo of new or improved varieties of economic plants is made either by means of exchanges with the Botanical Gardens or Agricultural Departments of foreign colonies, or by purchase, when large quantities of seed or of plants are required.

The Colonial Garden at Laeken, near Brussels

This garden was established with the object of cultivating and preparing interesting plants with a view to their introduction into the Colonies; it also makes exchanges with similar foreign establishments. There are now under cultivation in the greenhouses of this establishment 75 economic species and 200 botanical or ornamental species from the Congo, together with 550 other colonial species.

In order to accelerate the introduction of useful plants, an agent was sent, in 1913, to the British and Dutch East Indies to purchase large quantities of seeds and plants which were distributed among the experimental stations in the Colony, principally at Eala and Congo da Lemba. Tropical fruit trees of different varieties formed the principal part of these consignments, with palm trees, bamboos, rice, native food plants, etc.

PLANTATIONS

The number of plantations in the Belgian Congo supervised by Europeans is not yet very important, the greater number of the companies having only up to now bought from the natives rubber, copal, and ivory. Since the fall in the price of rubber, more attention has been paid to tropical plantations, and especially to the production of pea-nuts, coffee, cocoa, coconuts, palm oil and kernels, and cotton, as well as to the planting of different rubber trees.

Most of the plantations are established in Mayumbe and are devoted to the cultivation of cocoa. The area under cocoa is estimated at 9,500 acres, of which about 2,500 acres are in full bearing.

The plantations of rubber vines made by the State and the commercial companies have not yielded good results. The same may be said in general for the plantations of *Funtumia elastica*, the yield of which appears to be less than was hoped. Since 1910 a large quantity of Hevea has been planted, and more than 2,500 acres are devoted to this tree in the State plantations. The growth of these Hevea trees, when they are established in well-chosen ground, seems satisfactory and comparable with the growth in Malaya.

Colonisation

Efforts have been made during the last few years to introduce into certain parts of the Colony European agricultural colonists. The high-lying regions of the east and south appear suitable for a European population ; the heat is moderate and the climate seems to be healthy.

The first attempt of this kind was made in Katanga in the region of the copper-mines. An Agricultural Department was organised there in 1911 and 1912, and several experimental farms for cultivation and cattle-breeding were established. In the region where tsetse is prevalent, steam power has been used for clearing purposes, with a view to the creation of small farms and vegetable gardens in the neighbourhood of Elisabethville. The first Belgian colonists were established in farms completely equipped at the expense of the State. Italian farmers have been sent to Lower Congo. The results of this work are promising.

Cattle breeding can only be carried on in these regions on the high tablelands where the tsetse fly does not exist. Cattle introduced from Rhodesia soon become acclimatised and keep in good condition. It will be possible to develop this industry as soon as the Bukama railway reaches the tablelands.

Laboratories for Scientific Agricultural Research

The beginnings of the State agricultural service in the Belgian Congo were analogous to most of those in other colonies, work being limited to practical experiments in plant cultivation and to cattle breeding on the Government farms.

It is now recognised that these methods are not sufficient, and that the study of tropical agricultural problems requires scientific investigations, conducted by a staff trained in this kind of research and having at its disposal fully equipped laboratories.

The Agricultural Department has recently organised the following services of this kind :

Laboratories for the Study of Soils at Zambi and Elisabethville.—These two laboratories were created in 1913. They are under the management of two chemists, and a specialist has been sent to Germany, Austria-Hungary, and Russia in order to study the latest methods of soil research.

Laboratory for the Study of Plant Diseases.—A phytopathologist who has studied in the laboratories of mycology in the British and Dutch East Indies, during the year 1912, has been entrusted with the organisation of the service of phytopathology in the Belgian Congo. The laboratory will be erected at the Eala botanical garden. The first researches for this service were made in Mayumbe, on diseases of cocoa.

Laboratory of Applied Entomology.—The entomologist of the Agricultural Department commenced his researches in 1912 and 1913 at the Congo da Lemba station and in the Mayumbe cocoa plantations. The laboratory of entomology will be situated at Eala, to work in conjunction with the laboratory of mycology.

Veterinary Research Laboratory.—This establishment is situated at Zambi (Lower Congo), where special facilities are offered for studies in connection with the diseases of the different kinds of domestic animals, especially trypanosomiasis, and the tsetse fly. Two veterinary surgeons are stationed here ; one of them has worked for some time in the laboratories at Nairobi and Pretoria.

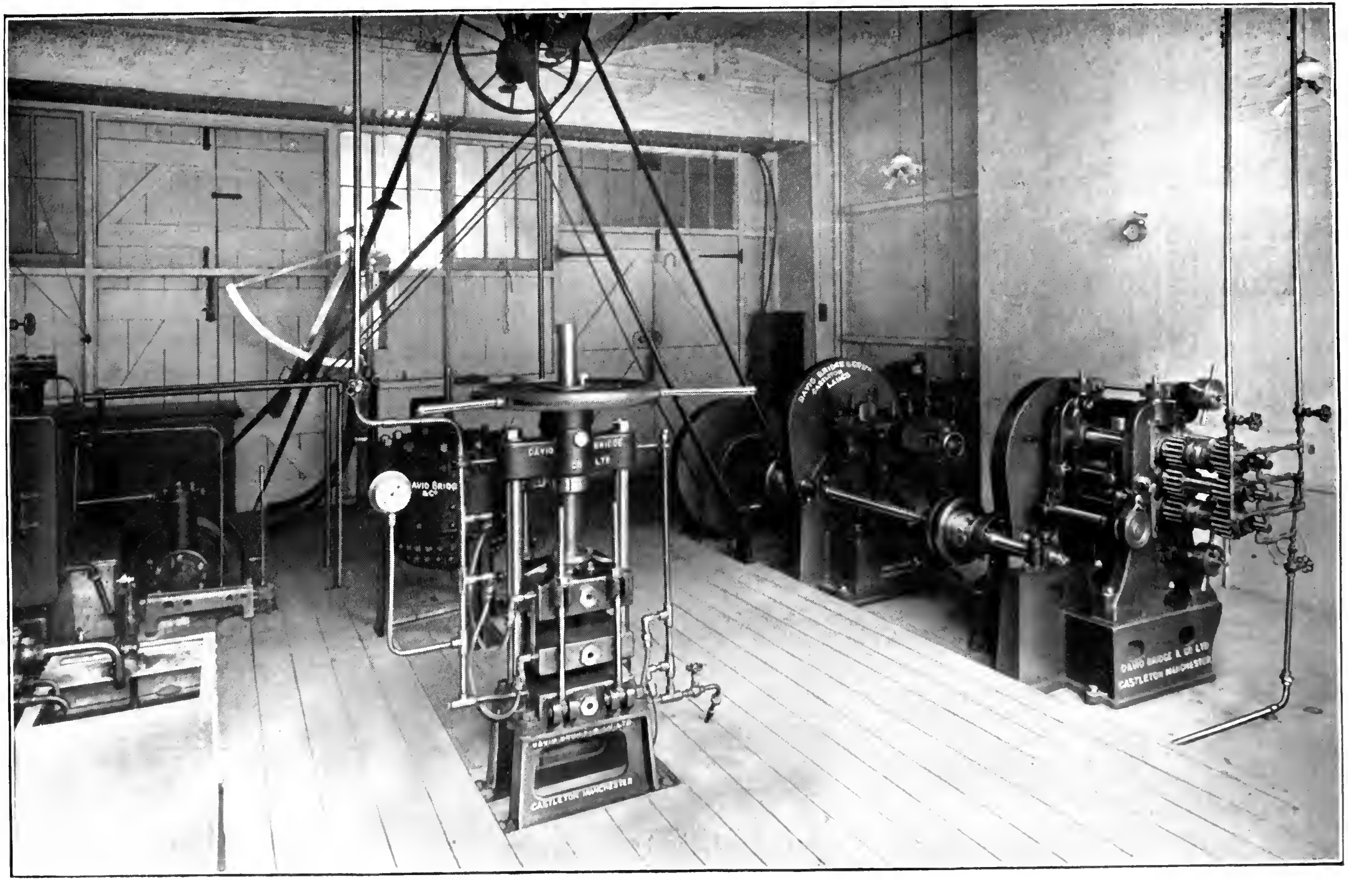
GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

RUBBER-TESTING MACHINERY AT THE IMPERIAL INSTITUTE

The methods adopted for the preparation of plantation Para rubber have given rise to considerable discussion among agricultural officers and planters in the East, and a number of proposals have been made with the view of raising the average quality of the rubber in comparison with fine hard Para, and of securing greater uniformity in different consignments. In this connection, however, it has been felt that the present methods of judging the quality of rubber in the sale room are exceedingly crude and unsatisfactory, and that the only way to secure accurate data for comparison would be to carry out a careful scientific investigation of series of samples of plantation Para rubber prepared in different ways.

There can be no doubt that the best and most trustworthy method of judging the quality of a sample of rubber is to vulcanise a portion and to submit the vulcanised product to mechanical tests, as by this means the behaviour of the rubber under manufacturing conditions can be studied and its technical quality and value determined. Some work on these lines has already been carried out, but much further investigation is required before the question of the best method of preparation for use on plantations can be solved. Recognising this fact, the Rubber Research Committee of Ceylon, in co-operation with the Department of Agriculture in the Colony, has arranged with the Imperial Institute to conduct a complete investigation of the whole question of the effect of different methods of preparation on the quality of the rubber, and this work is now in progress. A scheme of operations has been drawn up which includes the preparation in Ceylon of samples of rubber in different ways and under different conditions, care being taken that the individual factors are studied singly, and that specimens of rubber for comparison are prepared from the same sample of

PLATE I.



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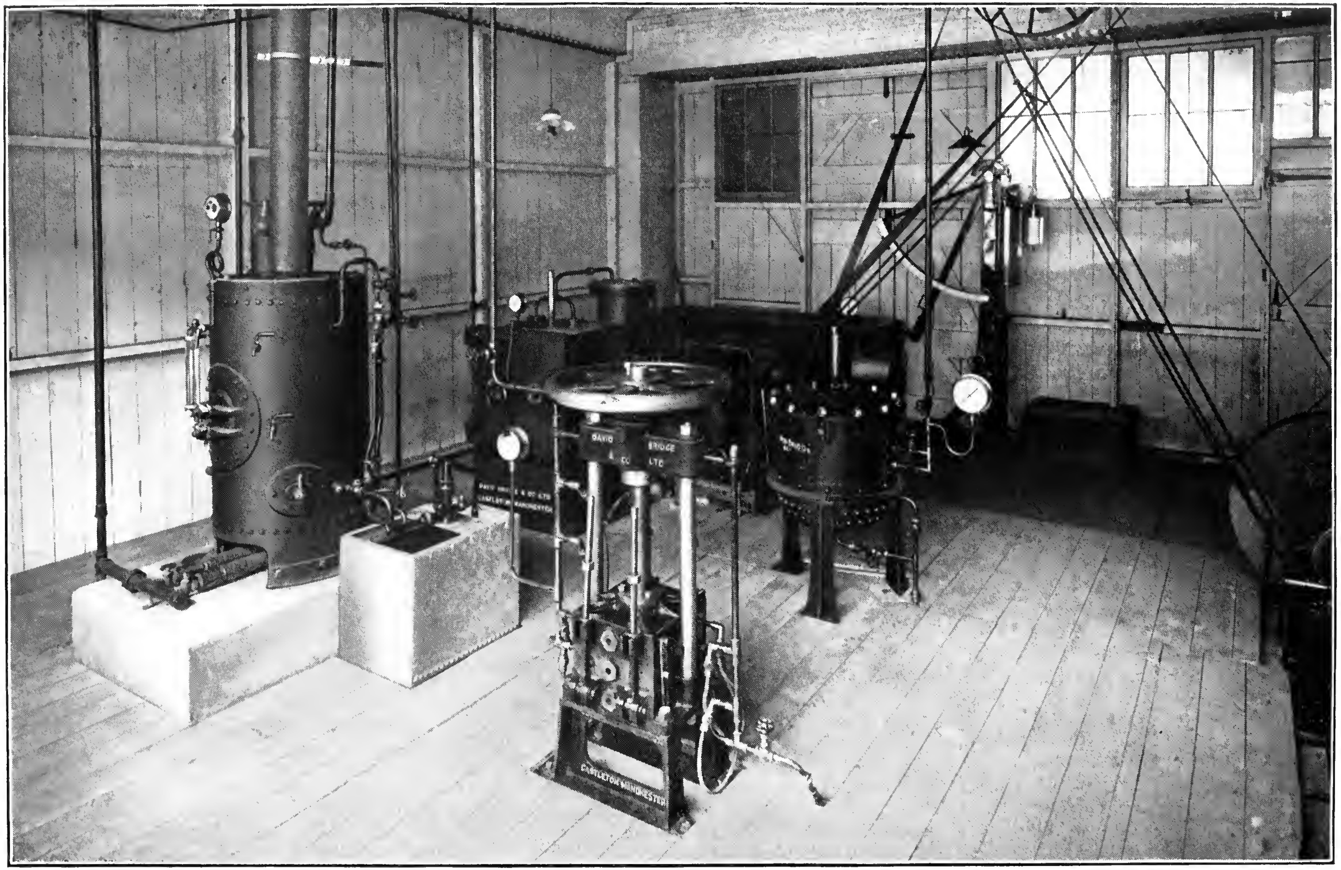
Imperial Institute Rubber Research Laboratory. West Side.

PLATE II.



Imperial Institute Rubber Research Laboratory. East Side.

bulked latex. The rubbers thus obtained are to be submitted to vulcanisation and mechanical tests, and for this purpose there has been installed at the Imperial Institute a complete experimental vulcanising and testing plant, a short description of which will be of general interest.

The plant required for the vulcanisation experiments, consisting of a washing machine, a mixing machine, a three-bowl calender, a vulcanising press, a vulcanising pan, a vacuum drier, and a gas-fired boiler, has been supplied and erected by Messrs. David Bridge and Co., of Castleton, Manchester, the well-known rubber machinists, and embodies all the improvements which have suggested themselves to the firm as the result of their experience of the working of previous installations of the same kind. One of the large rooms in the basement of the Imperial Institute has been specially allocated for the reception of the machines and forms a completely equipped research laboratory for the mechanical testing of rubber (see Plates I and II). The chemical investigation of rubbers will be conducted, as heretofore, in the main laboratories of the Scientific and Technical Department.

The washing machine is fitted with diamond-cut chilled cast iron rollers, 4½ in. in diameter and 9 in. long, the front roller being adjustable by means of a worm and worm wheel adjustment gear; it is supplied with hot and cold water for washing purposes.

The mixing machine has accurately turned, ground, and polished rollers, of the same size as those of the washer and adjustable by the same means. The rollers are hollowed and are fitted with water and steam connections so that they can be used either hot or cold (Plate III, Fig. 1).

The calender is fitted with three rollers similar to those of the mixer and adjustable by means of worm and worm wheel adjustment gear; it is provided with special cut gear and clutches so that the three rollers can be run at equal speeds or a friction speed obtained between the adjacent rollers, the changes being obtained by a simple movement of the clutches. The rollers can be either steam-heated or water-cooled (Plate I, right foreground).

These three machines are driven by electric motors

through line shafting and cut gear; each machine being fitted with a Heywood and Bridge patent friction clutch.

The screw vulcanising press is furnished with three steam-heated platens, 12 in. square, which are machined and polished on the working faces. Each platen is provided with separate steam and drainage connections and thermometer (Plate I, centre foreground).

The vulcanising pan, which is 18 in. deep and 18 in. in diameter, is so arranged that vulcanisation can be conducted either in live steam (by injecting steam into the pan) or in dry heat (by allowing the steam to enter only the jacket of the pan). It is fitted with the necessary steam and drainage connections, steam gauge, and thermometer (Plate III, Fig. 2).

The vacuum drier is one of Bridge's improved patent vacuum drying installations, of suitable size for experimental purposes; it is provided with steam-heated platens, condenser, receiver, and vacuum pump, the latter being driven by belts and pulleys from an electric motor.

The steam required for the working of the plant is supplied by means of a small vertical gas-fired boiler.

For the determination of the mechanical properties of vulcanised rubber, it is generally recognised that the machine designed by Herr Louis Schopper is one of the most efficient and satisfactory, and a machine of this type, with the latest improvements, has been obtained for testing purposes (Plate IV). The test pieces for use with this machine are cut from vulcanised sheet in the form of rings of standard dimensions by means of a series of circular cutting knives, and these rings are evenly rotated during the application of tension. The machine can be used to determine the breaking strain and the elongation at the breaking point; the elongation with fixed load; the load required for fixed elongation, etc. The machine is also fitted with an automatic apparatus for drawing hysteresis diagrams. The permanent or sub-permanent set of rubber after extension will be determined by means of a special apparatus, and other testing machines will be added during the progress of the investigation.

It is anticipated that work on these lines, carefully and

PLATE III.

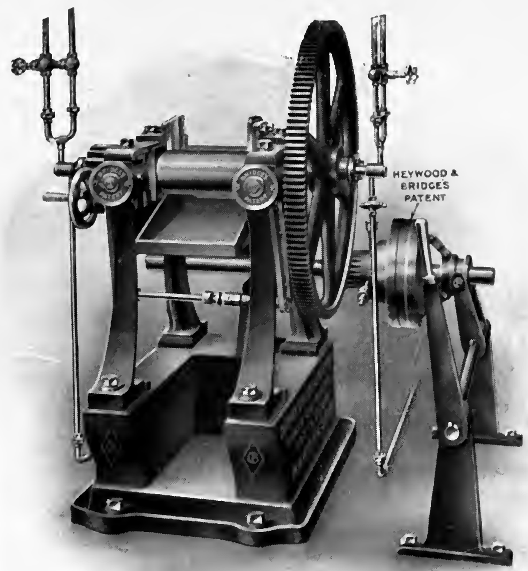


FIG. 1.—Mixing Machine.

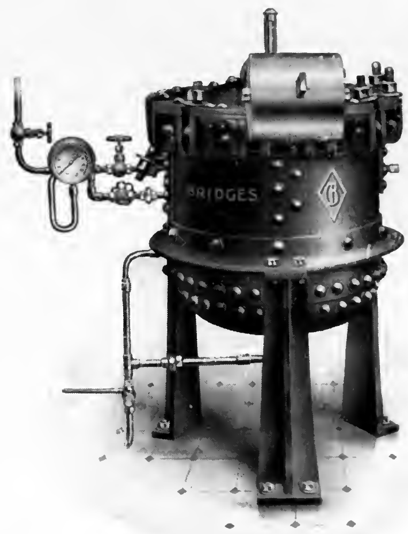


FIG. 2.—Vulcanising Pan.

Plate IV.

Schopper's Rubber Testing Machine.

systematically conducted, will throw considerable light on the effect of different methods of preparation on the quality of the rubber, and will enable a method to be selected for use on plantations which will produce rubber of the highest possible quality for manufacturing purposes.

THIRD INTERNATIONAL CONGRESS OF TROPICAL AGRICULTURE, LONDON, 1914

One of the most remarkable commercial developments of recent years has been the increase in the capital employed in planting enterprises in the tropics. It has been estimated that at the present time the nominal capital of rubber-planting companies registered in the United Kingdom is approximately £100,000,000 sterling. This figure gives some indication of the magnitude of the world's interests in tropical planting, for it must be remembered that plantation rubber is only one out of numerous necessities of modern life for which the world is dependent on tropical agriculture. In this connection it is sufficient to mention such tropical crops as tea, coffee, cocoa, tobacco, coconut oil, cotton, jute, Sisal hemp, and cinchona, in the production of which large interests are involved. Equally important is the exploitation of tropical forest products, such as mahogany and other hardwoods, native rubber, gutta-percha, palm oil and palm kernels, tanning materials, and a host of less important products. It is not, perhaps, generally realised that the successful continuation of these industries has meant the creation in the tropics, and in the countries which possess tropical colonies, of official and other organisations for the conduct of scientific investigations to solve the innumerable new and difficult problems which have arisen in connection with agriculture and forestry in the tropics. It is nevertheless true to say that practically every tropical colony and every colonising country now possesses one or more organisations of this kind. Certain of the fundamental problems, which all these organisations are studying, are common wherever tropical agriculture is practised, and it is clear that some international means for the exchange of ideas on these

problems is desirable. It was with this object that the International Association for Tropical Agriculture, or, to use the official French title, l'Association Scientifique Internationale d'Agronomie Coloniale et Tropicale, was founded in 1905. This Association has its headquarters in Paris, and is represented in the countries concerned either by a National Section of the Association or by a Vice-President of the Association, or in some cases by an affiliated Society.

National Sections have so far been organised in France, Germany, Italy, and the United Kingdom.

The Association is governed by an International Bureau composed as follows:

MEMBRES DU BUREAU INTERNATIONAL DE L'ASSOCIATION

PRÉSIDENT EN EXERCICE (1910–1915):

M. le Prof. Dunstan, Directeur de l'Institut Impérial, Londres, Membre de la Société royale de Londres.

PRÉSIDENT SORTANT (1-ÈRE PÉRIODE D'EXERCICE, 1905–1910):

M. le Prof. J. L. de Lanessan, ancien Ministre, ancien Gouverneur Général de l'Indo-Chine.

VICE-PRÉSIDENTS:

Allemagne.—M. le Prof. A. Engler, Membre de l'Académie des Sciences de Berlin, Directeur des Musée et Jardin botanique royaux de Berlin, et de la Station botanique centrale pour les Colonies allemandes.

M. le Prof. Dr. Wohltmann, Conseiller privé, Directeur de l'Institut agricole de l'Université de Halle sur Saale.

Angleterre.—M. le Colonel Sir D. Prain, Directeur du Jardin royal, Kew, Membre de la Société royale de Londres.

Indes-britanniques.—M. Bernard Coventry, Conseiller agricole du Gouvernement.

Belgique.—M. Ch. Liebrechts, Conseiller d'État à Bruxelles.

M. E. Leplae, Directeur Général de l'Agriculture du Congo Belge, au Ministère des Colonies à Bruxelles.

M. E. de Wildeman, Directeur du Jardin botanique de l'État.

Brésil.—S.E.M. Olyntho de Magalhaes, Ministre du Brésil à Paris.

Egypte.—M. G. C. Dudgeon, Conseiller Agricole du Gouvernement au Caire.

Equateur.—S.E.M. le Dr. Rendon, Ministre de l'Equateur à Paris.

Espagne.—M. le Prof. Vincente Arche, Chef des Services de l'Enseignement et de l'Expérimentation agricoles, au Ministère de l'Agriculture, à Madrid.

M. E. Gomez Flores, Chef du Service agronomique des Canaries, à Las Palmas.

France.—M. le Myre de Villers, Ambassadeur, Président honoraire de la Société d'Acclimatation de France.

M. le Prof. Muntz, de l'Institut national agronomique, Membre de l'Académie des Sciences de Paris.

M. le Prof. Edmond Perrier, Directeur du Muséum national d'Histoire naturelle, Membre de l'Académie des Sciences de Paris.

M. le Prof. Prillieux, de l'Institut national agronomique, Membre de l'Académie des Sciences de Paris.

M. le Dr. Roux, Directeur de l'Institut Pasteur, Membre de l'Académie des Sciences de Paris.

M. Tisserand, Directeur honoraire de l'Agriculture de l'Académie des Sciences de Paris.

Italie.—S.E.M. le Prof. Nitti, Ministre de l'Agriculture, de l'Industrie, et du Commerce à Rome.

S.E.M. le Prof. Sanarelli, Secrétaire d'État au Ministère de l'Agriculture, de l'Industrie et du Commerce à Rome.

M. le Comte Sabini, Attaché commercial à l'Ambassade d'Italie à Paris.

Mexique.—S.E.M. de Mier, ancien Ministre du Mexique à Paris.

S.E.M. Olegario Molina, ancien Ministre de l'Agriculture à Mexique.

Pays-bas.—M. le Prof. H. J. Lovink, Directeur Général du Départment de l'Agriculture, des Indes néerlandaises à Buitenzorg.

Portugal.—M. le Prof. Freire d'Andrade, Directeur Général des Colonies, au Ministère des Colonies, à Lisbonne.

S.E.M. le Prof. Batalha-Reis, Ministre du Portugal à Saint-Pétersbourg.

M. le Prof. J. Henriques, Directeur du Jardin botanique de l'Université de Coimbra.

M. le Prof. de Monte-Pereira, ancien Directeur au Ministère des Colonies, à Lisbonne.

Russie.—M. le Prof. Boris de Fedtschenko, du Jardin botanique impérial de Saint-Pétersbourg.

Turquie.—M. le Prof. Hassib Bayindirly, Directeur de l'Enseignment agricole au Ministère de l'Agriculture, à Constantinople.

ADMINISTRATEUR-TRÉSORIER :

M. S. de la Rupelle, Secrétaire général de la Société générale pour favoriser le développement des Commerce et de l'Industrie, à Paris.

SECRÉTAIRE PERPÉTUEL :

M. le Dr. F. Heim, Professeur à l'école nationale supérieure d'Agriculture coloniale, et au Conservatoire nationale des Arts et Métiers.

Apart from the conduct of special enquiries and the publication of reports on these enquiries, the work of the Association consists principally in holding periodically International Congresses of Tropical Agriculture. The first of these was held in Paris in 1905, and the second in Brussels in 1910. The third Congress will be held in London at the Imperial Institute from June 23 to 30, this year. The organisation of the London Congress has been entrusted to the British Section of the Association, which has its headquarters at the Imperial Institute. The following Organising Committee was appointed early in 1913 and has now practically completed its preparations for the Congress :

ORGANISING COMMITTEE FOR THE CONGRESS IN LONDON

Chairman—Prof. Wyndham R. Dunstan, C.M.G., M.A., LL.D., F.R.S.

MEMBERS

Mr. M. Kelway Bamber, Government Chemist, Ceylon.
Mr. J. R. Blackwood, Director of Agriculture, Bengal.
Mr. J. R. Bovell, I.S.O., Superintendent of Agriculture, Barbados.
Mr. I. H. Burkill, M.A., F.L.S., Director of Gardens, Singapore.
Prof. P. Carmody, Director of Agriculture, Trinidad.
Mr. D. T. Chadwick, Director of Agriculture, Madras.
Mr. B. Coventry, C.I.E., Agricultural Adviser to the Government of India.
Dr. C. W. Daniels, Medical Adviser to the Colonial Office, London.
Mr. M. T. Dawe, late Director of Agriculture in the Territory of the Mozambique Co.
Prof. F. Debono, Inspector of Agriculture, Malta.
Mr. G. C. Dudgeon, Consulting Agriculturist, Ministry of Agriculture, Egypt.
Mr. P. R. Dupont, Curator, Botanic Station, Seychelles.
Dr. E. Goulding, Imperial Institute, London.
Mr. E. Ernest Green, late Government Entomologist, Ceylon.
Mr. W. S. Hamilton, Director of Agriculture and Industries, Punjab.
Prof. J. B. Harrison, C.M.G., Director of the Department of Science and Agriculture, British Guiana.
Mr. W. Hopkins, Director of Agriculture, Sierra Leone.
Mr. A. E. Humphries.
Mr. J. A. Hutton, Chairman, British Cotton Growing Association.
Mr. W. H. Johnson, Director of Agriculture, Southern Provinces, Nigeria.
Mr. C. H. Knowles, Superintendent of Agriculture, Fiji.
Mr. P. H. Lamb, Director of Agriculture, Northern Provinces, Nigeria.
Mr. L. Lewton-Brain, Director of Agriculture, Federated Malay States.
Mr. R. N. Lyne, Director of Agriculture, Ceylon.
Mr. A. C. MacDonald, Director of Agriculture, East Africa Protectorate.
Mr. J. MacKenna, Director of Agriculture, Burma.
Mr. J. S. J. McCall, Director of Agriculture, Nyasaland.
Mr. F. C. McClellan, Director of Agriculture, Zanzibar.
Mr. J. McSwiney, Director of Land Records and Agriculture, Assam.
Dr. E. A. Nobbs, Director of Agriculture, Rhodesia.
Lt.-Col. Sir D. Prain, C.M.G., C.I.E., LL.D., F.R.S., Director, Royal Botanic Gardens, Kew.
Mr. H. N. Ridley, C.M.G., F.R.S., late Director of Gardens and Forests, Singapore.
Mr. S. Simpson, B.Sc., Director of Agriculture, Uganda.
Mr. H. Hamel Smith, Editor of *Tropical Life*, London.
Mr. F. A. Stockdale, Director of Agriculture, Mauritius.
Sir Stewart Stockman, Chief Veterinary Officer, Board of Agriculture and Fisheries, London.
Mr. W. S. D. Tudhope, Director of Agriculture, Gold Coast.
Mr. W. T. Tutcher, Superintendent, Botanical and Forestry Department, Hong Kong.
Dr. F. Watts, C.M.G., Imperial Commissioner of Agriculture for the West Indies.
Dr. T. A. Henry, Imperial Institute, London, } Honorary Secretaries.
Mr. Harold Brown, Imperial Institute, London, }

It will be seen that practically every tropical colony in the British Empire is represented on this Committee by its principal agricultural officer.

The committees of the various national sections are also actively engaged in promoting the interests of the Congress in their own countries and colonies.

Official notifications regarding the Congress have been issued by the British Foreign Office and by the Ministère des Affaires Étrangères in Paris, to the Governments of all countries possessing tropical colonies, and to States lying within the tropics, inviting them to support the Congress by appointing official delegates and in other ways.

A large number of institutes, associations, societies, chambers of commerce, and other unofficial bodies, British and foreign, interested directly or indirectly in tropical agriculture and colonial development, have already responded to the invitations issued by the Organising Committee, and will be represented at the Congress by special delegates.

Provisional Programme of the Congress

The Congress will be held at the Imperial Institute, South Kensington, London, S.W. It will open on Tuesday, June 23, and close on Tuesday, June 30, 1914.

In the order of business at the meeting, the morning sittings (10 a.m. to 1 p.m.) will be reserved for papers and discussions on subjects of general importance, each morning being devoted to a single subject; the afternoon sittings (3 to 5 p.m.) will be reserved for papers and discussions on special subjects.

Communications intended for the Congress may be made in English, French, German, or Italian; but the general language of the Congress will be English.

The following subjects are suggested for papers and discussion at the morning meetings:

Technical Education and Research in Tropical Agriculture.

Labour Organisation and Supply in Tropical Countries.

Scientific Problems of Rubber Production.

Methods of Developing Cotton Cultivation in New Countriés.
Problems of Fibre Production.
Agricultural Credit Banks.
Agriculture in Arid Regions.
Problems in Tropical Hygiene and Preventive Medicine.

Papers for the afternoon meetings are invited on the following subjects:

I. Problems relating to Tropical Agriculture and Forestry.

II. The Cultivation and Production of—

Rubber.	Tea.
Cotton and Fibres.	Coconuts.
Cereals and other Foodstuffs.	Other Agricultural Products.
Tobacco.	Forest Products.

III. Plant Diseases and Pests affecting Tropical Agriculture.

Papers recommended for publication and Reports of Discussions will be published at the close of the Congress.

A considerable number of papers on these various subjects has been promised already by well-known experts in tropical agriculture, and there can be no doubt that the discussions which will take place at the Congress will be of great value to all interested in these matters.

Membership Subscriptions and Correspondence

The subscription for membership of the Congress will be £1, entitling members to admission to all meetings and receptions, and to receive the volume of printed papers and discussions, on publication. Those desiring to become members of the Congress are requested to send their subscriptions to the Organising Secretaries, Third International Congress of Tropical Agriculture, Imperial Institute, London, S.W., as soon as conveniently possible, in order that their names and permanent addresses may be registered.

A special circular, with the complete arrangements, will be forwarded to all registered members before the meeting.

THE CULTIVATION AND PREPARATION OF RICE. PART II

(*Continued from Vol. xi., p.* 655)

PESTS AND DISEASES

THE rice-crop is subject to the attacks of rats, birds, insect pests, and fungoid diseases, but many of these are only of local importance, and very few are sufficiently abundant to make any impression on the crop. The nature of the crop and the extensive area it occupies preclude the employment, on a large scale, of insecticides; consequently, in dealing with insect pests preventive measures play an important part. The fungoid diseases or "smuts" to which some varieties are subject are best controlled by growing immune varieties.

In dealing with rats, it is necessary to co-operate for the purpose of destroying them over large areas at one time, individual effort in dealing with this pest being practically useless. Trapping is the common method employed; many poisons are also in use, but these are not very effective in tropical countries. One of the most effective methods of eradicating rats is by using carbon disulphide. A teaspoonful of this compound poured into the entrance of a burrow, the mouth of which is then closed, is sufficient to asphyxiate all the rats there may be within. It is however a dangerous and inflammable substance, and should only be used by careful persons acquainted with its properties.

Insect Pests

Of a number of insect pests that attack rice the following are the more important:

The rice grasshopper (*Hieroglyphus banian*, Fabr.) has a wide and general distribution throughout India, and attacks other grasses, such as sugar-cane, as well as rice. It feeds upon the leaves of the rice-plant, but causes most damage by cutting through the upper part of the stalk, thereby causing the heads of grain to fall. The grasshopper hatches out from eggs which are laid in masses about 2 in. below the surface of the soil, usually in the banks

or bunds surrounding rice-fields, but never in the fields themselves. About one half of the year, the dry season, is spent in the egg stage; during the other half the grasshopper lives above ground. During a great part of their development the insects feed on the grass on the bunds bordering the rice-fields, whence they migrate to the rice-fields themselves. The best time for combating them is during the early stages, as soon as they emerge from the eggs and while they are still living on the bunds. Bagging is the most efficient method of destroying them. This method consists in dragging over the bunds a bag of cotton cloth, by which means large numbers of grasshoppers are caught. The captured insects are killed either by crushing them or by emptying the bag into a vessel containing water mixed with a small quantity of kerosene. The bags used successfully in Mysore for this purpose measure about 7 ft. in length and 3 to 4 ft. by 1½ to 2½ ft. at the mouth. On each of the two narrow sides of the mouth of the bag, a bamboo pole 3 to 4 ft. in length is fixed. The poles keep the mouth of the bag open and taut when in use and also serve as handles for dragging the bag over the ground. Two men are necessary to drag the bag, and it is essential that they should move as quickly as possible while doing so. It is important that the bagging should be done early, when, if concerted action be taken, much can be done towards reducing the damage caused by this pest. An experimental bagging in Mysore in 1911 resulted in a catch of 43,000 grasshoppers in about one hour, with one bag, over about 185 yards of bund, which bordered at least 2 acres of rice-fields. (Cf. *Bulletin* No. 1, 1911, *Entom. Ser.*, *Dept. Agric.*, *Mysore State*, and *Bulletin* No. 67, 1913, *Dept. Agric.*, *Madras*).

The rice hispa (*Hispa armigera*, Oliv., syn. *H. ænescens*, Baly), a small blue-black beetle covered with spines, occasionally causes damage to the rice crops in India. It sometimes appears in enormous swarms, and then causes wholesale destruction. Usually it feeds on the young rice-plants in seed-beds or in newly planted fields; it eats the cellular tissue but rejects the fibrous vascular bundles, and as a result of its attacks the plants assume a white and

withered appearance. The eggs are laid singly in the tissue of the leaf, and the whole life of the beetle is spent within the leaf until the mature insect emerges. Wild jungle grasses are the normal food plants of the beetle, and from these it flies to the rice-fields. Preventive measures are important in dealing with this pest, and it is necessary to watch seed-beds closely in order to prevent eggs being deposited on the seedling rice-plants. Sometimes it is possible to destroy it in its breeding places in the jungle before it migrates to the rice-fields; at other times, by hastening or delaying the time of transplanting, the seedlings may escape from its attacks. At Sibpur Experimental Farm seedlings were protected by being dipped in a solution of asafœtida before being transplanted. Submerged lowland rice is attacked in preference to rice on higher land, and cultivators, in view of this, sometimes run off the water from their fields in order to induce the beetles to leave. When present in large numbers the beetles may be caught in bags as described above. Some soft-leaved varieties of rice are found more liable to attack than rough, hard-leaved sorts, and where this pest is prevalent the latter should be grown.

The rice-bug (*Leptocorisa varicornis*, Fabr.), a slender green insect with long antennæ, injures rice and other cereals by sucking the milky juice from the developing grain, thereby causing the ears to turn white. The bugs hatch out from eggs which are laid on jungle plants and also on the leaves of rice. The eggs are oval, somewhat flattened, black and seedlike in appearance, and are deposited in groups of ten or more. The young insects are wingless, but wings develop gradually, and mature insects may be found actively flying in the rice-fields. If early and concerted action be taken, and large areas treated at the same time, the method of bagging suggested for controlling rice grasshoppers (p. 86) is found to be efficacious in checking this pest. The simplest plan is to draw the bag quickly through the growing rice, by which means large numbers of both winged and wingless forms are captured. As the full-grown bugs are capable of flying from one field to another, large areas require

to be swept simultaneously. The larvæ of the six-spotted tiger beetle (*Cicindela sexpunctata*, L.), a predaceous beetle common in the rice-fields of Bengal, feed on the rice-bug, and help to keep it in check.

The rice stem-borer (*Schœnobius bipunctifer*, Wlk.), a small moth which lives in the stem of the rice-plant during the larval stage, causes damage to the flower-spike by feeding above the upper node of the stem, as a result of which the flower-spike becomes withered and bleached. After reaching the top of the stem the larva emerges and constructs for itself a bag-like covering made from a portion of the leaf of the rice-plant. In this it remains for about a week, and then re-enters the stem of the plant near the base. It there spins a cocoon and undergoes metamorphosis, and in about ten or twelve days' time the mature moth emerges. There are no methods of controlling this pest practised, but it is suggested that, as the affected plants are readily distinguished owing to the bleached appearance of the flower-heads, they should be pulled up and burnt while still containing the pupa of the moth. If this were practised thoroughly over large areas for a few seasons, this pest would no doubt eventually be eradicated. The use of light-traps at night to attract the moths has also been suggested.

The caterpillar of *Nymphula depunctata*, Gn., a small moth, is frequently a serious pest of the rice-plant in Southern India. It is semi-aquatic in habit, and lives in cases constructed of rolled pieces of leaf. It causes damage by feeding on the leaves and tender green tissues. The native treatment consists in dragging branches over the fields to dislodge the cases and draining off the water; but as the pest is frequently found in low, water-logged areas, which cannot be drained, this treatment is not always possible.

The rice weevil (*Calandra oryzæ*, L.), a small insect about ⅛ in. in length, with a prominent curved snout, attacks rice and other grain stored in warehouses. It is abundant in India, and is known throughout the rice-producing countries. It may be killed by treating the grain with carbon disulphide at the rate of 1 oz. per

cubic foot of space for twenty-four hours; but, as noted above, great care must be taken in using this highly inflammable and explosive substance.

The rice water-weevil (*Lissorhoptrus simplex*, Sarg.) is the most serious insect pest of the rice crop of the southern states of North America. The adult weevils measure about 3 mm. in length, and are capable of moving about freely in water. The larvæ feed on the roots of the rice-plant, and the adult insects cause damage by eating the leaves. Deep and stagnant water on the rice-fields encourages the development of this pest, while dry conditions check its spread. It has been found advantageous where this pest is present to merely soak the soil instead of flooding the rice-fields, especially during the early stages of growth. The practice of drawing off the water from the infected fields and allowing them to become somewhat dry before re-flooding them tends to check the ravages of this pest during the early stages of infection; good cultivation also greatly assists in combating this weevil, as weeds which would serve as host-plants are thereby eliminated, and the rice-plants, rendered more vigorous, are better able to withstand its attacks. The levelling of the surface of rice-fields so as to do away with depressions which would hold stagnant water and serve as breeding grounds for the weevil, is a necessary precaution.

Caterpillars.—Young rice-plants are very liable to be attacked by caterpillars of several species, and in dealing with these, as with other insect pests, preventive measures are more important than remedies. The normal food of caterpillars is the vegetation of the banks and waste lands surrounding rice-fields. The importance of cutting down and burning this is therefore obvious, as by this means large numbers of caterpillars are destroyed and their excessive increase checked. If possible, infested land surrounding rice-fields should be rolled in order to crush the caterpillars, and so prevent their migrating to the rice-fields. An effective bar to the passage of swarming or migrating caterpillars is a trench about 1 ft. deep, opened across their path; if the side of the trench nearest the caterpillars be made gently sloping and the opposite

side upright or concave, the caterpillars will enter the trench, but will be unable to crawl up the concave side. If pits, 1½ to 2 ft. deep, be opened at intervals along the bottom of the trench, many of the caterpillars will fall into them in seeking a way out, and may then be easily destroyed. Infected portions of rice-fields may be isolated in the same way, or by means of water channels. A channel of water surrounding rice-fields or seed-beds affords an effective barrier against caterpillars, but the channel must be kept free from weeds, which, if present, would form a bridge for the caterpillars. When present in small numbers only, caterpillars may be controlled by hand picking. This should be done early, as soon as the first brood appears, otherwise the second brood will, under favourable circumstances, be more numerous and more difficult to cope with. On the bunds, if found in masses, they may be destroyed by dusting them with quicklime.

Ufra Disease.—This disease has been known for some years in the delta region of Eastern Bengal, but is said to have increased in virulence in recent years. Three stages or forms of the disease are recorded: (1) the plants are affected before the ears form, and the leaves assume a reddish or brownish appearance and ultimately wither; (2) the upper portion of the plants becomes swollen and the inflorescence remains enclosed within the sheath; (3) the ear emerges from the sheath, but the peduncle becomes shrunken and the grain fails to set. In all these there is a reddish or brownish discoloration of the plant confined to a limited area, usually about the nodes, and often only in the upper parts of the plant. The disease is believed to be due to an eel-worm (*Tylenchus angustus*, Butler), of minute size, scarcely visible to the unaided eye. On diseased plants this worm is found in the early stages occupying small brown patches on the leaves and culm, and as the crop approaches maturity large numbers are found on the peduncle of the ear, at which points the culm becomes blackened, and shrunken to about the thickness of a thread.

This disease is found chiefly on broadcasted *aman* rice, and the conditions under which this crop is grown

probably favour this disease. A long stubble is left after harvesting the crop, and this is trampled down by cattle and, at the time of sowing a new crop, is ploughed in; either the crop or stubble is therefore on the land for the whole year. As a preventive measure it is suggested that the land be ploughed as soon as the crop is harvested, and the straw and stubble burnt in order to thoroughly clean the land between successive crops (see *Bulletin* No. 34, 1913, *Agric. Research Inst. Pusa*).

Fungoid Diseases

"Blast" or "rotten-neck" (*Piricularia oryzæ*, Cav.), a world-wide rice disease, attacks the rice-plants at the sheath nodes, where the blade of the leaf joins the sheath, and more frequently at the lowest joint of the head of grain (the "neck"). The chief damage caused by this disease is the failure of the grain to fill on the diseased stalks, and the production of light grain of poor quality. Many of the diseased heads of grain bend over or fall off by their own weight when the disease occurs in the "neck" region. The withholding from the soil of rich nitrogenous manures, and the removal by burning of all organic refuse after harvesting the crop, are preventive measures that should be observed. In Italy this disease is said to have been eradicated by the cultivation of resistant varieties.

False or green smut (*Ustilaginoidea virens* [Cke.] Tak.) attacks the rice-grain, which, as a result, becomes large and swollen, and filled with a compact, white mass bordered by a yellowish-brown layer, and on the outside coated with a dark green powder. Usually this disease is not serious, and only a few grains per head of the affected plants are attacked (*loc. cit.*).

Black smut or bunt (*Tilletia horrida*, Tak.) converts the grain of rice into dark, powdery masses of spores, but produces little change in the external appearance of the grain. The mycelium of the fungus lives within the stem of the rice-plant, and infection probably takes place during the seedling stage. In South Carolina this disease is said to have been stamped out by selecting the seed intended for sowing by the salt-water method. The seed

is immersed in salt water, and the infected seeds, which are lighter than the sound grains, are floated off. The remaining seed is then treated for twenty-four hours in a mixture of "liver of sulphur" and water ($1\frac{1}{2}$ lb. to 25 gallons of water) before sowing. Seed from smut-infected fields should not be used for sowing, but in cases where this is unavoidable it should be subjected to the above treatment or should be steeped in a solution of formalin ($\frac{1}{2}$ pint of 36 to 40 per cent. water solution of formalin to 20 gallons of water) before being sown. The seed should remain in the solution about half an hour, and should be stirred repeatedly during the immersion, the seeds that float being skimmed off.

Light or Sterile Grains.—A large proportion of the light and sterile grains found in rice results from the attacks of insects, but a certain quantity of light grain is believed to be due to the attacks of *Sclerotium oryzæ*, Catt., a parasitic fungus found on rice-plants in the Madras Presidency, India, and also recorded as occurring in Japan and Italy. This fungus attacks the base of the stem of the rice-plant, causing discoloration of the lowest internode and the decay of the lower leaf-sheaths. The infected plants are markedly late in tillering, and develop a number of green, sterile shoots from the basal nodes of the stalks, and the ears, although normal in appearance, do not mature a full proportion of their grain. The life-history of this fungus is imperfectly known, and the amount of damage for which it is responsible has not yet been estimated, but in all probability it is not great.

Preparation of Rice

Rice Milling.—The grain, as separated from the rice-plants by thrashing, is known as "paddy" (padi). In this state it is enveloped in a close-fitting husk or hull, which has to be removed in order to render the grain suitable for consumption. The usual native method of husking rice is by pestle and mortar, the chaff or hulls being subsequently separated from the grain by winnowing. In some parts of India the pestle is attached to a beam which is worked by the foot of the operator; in other

countries, as in some parts of Japan, an overshot water-wheel supplies the motive power. To facilitate the removal of the husk, paddy is sometimes partially boiled, and then dried in the sun before treating by pestle and mortar; such rice is termed "parboiled rice." Husking without boiling is, by primitive methods, a tedious and laborious operation. Transportable machines operated by either hand-, horse-, or bullock-power, are now on the market, capable of husking paddy, and these will in all probability eventually oust the more primitive appliances for local use. Similar machines for winnowing and grading the grain are also available. In all the important rice-exporting countries there are large rice-mills, the most important being those in Burma, which are fitted with elaborate power-driven machinery by which paddy is treated for export.

The process of milling is briefly as follows: The paddy is first sifted in order to remove dirt or other foreign matter with which it may be mixed; the husks are then removed by passing the grain through milling stones or a system of hullers, screens, and winnowing-machines. The husked rice is next milled in cones to produce "white rice," during which process the pericarp is removed with much of the aleurone-layer of the endosperm, and also the embryo or "germ," and these together constitute rice "bran" or meal. It is finally polished by being placed in cylinders of wood and wire gauze fitted inside with revolving rollers covered with sheep-skin, which remove all floury matter from the grain, and give it a fine, smooth surface. Powdered talc (French chalk) or steatite is sometimes used as a polishing material during this process. The floury matter removed by polishing is known as "rice polish." The polished grains are finally screened into various grades, and a percentage of the broken kernels is removed, which varies according to the quality of rice that is being prepared; for example, in Rangoon there are five qualities of white rice recognised in the trade, the proportion of broken to whole grains being from 25 per cent. in the highest quality to 55 per cent. in the lowest. Practically all the phosphates in rice are contained in

the pellicle which is removed by the polishing process. The elimination of the phosphates greatly diminishes the nutritive value of the grain, and an exclusive diet of polished rice is by some authorities held to be responsible for the disease known as beri-beri.

Large quantities of incompletely husked rice, known as "cargo rice," are shipped from producing countries. The proportion of unhusked grain varies from 5 to 20 per cent. according to the extent of milling it has undergone. Cargo rice is largely shipped to European countries, and also in smaller quantities to America and Australia, where it undergoes further milling according to local requirements. It is probable that protective tariffs as well as local requirements are responsible to a certain extent for the large quantities of rice imported in this partially prepared form instead of in the form of white rice suitable for immediate consumption. Most of the rice consumed in the United Kingdom is obtained from India. Large quantities are also imported from the Netherlands, where rice-milling is an important industry, the rice being imported mainly in the form of cargo rice from Java, Rangoon, Bassein, Saigon, and Japan.

The following table, compiled from the *Annual Statement of the Trade of the United Kingdom with Foreign Countries and British Possessions*, 1912 [Cd. 6810], gives the quantities and values of whole and cleaned rice imported into this country during the years 1910–12, and also the countries whence the imports were consigned:

	1910.	1911.	1912.	1910.	1911.	1912.
	cwts.	*cwts.*	*cwts.*	£	£	£
Netherlands	566,912	564,590	447,280	351,971	352,489	313,078
Germany	143,980	184,490	93,254	79,205	104,926	56,561
Italy	7,000	14,670	41,549	6,507	10,210	34,974
Siam	342,401	125,583	70,660	152,958	61,388	41,446
Japan (including Formosa)	106,810	64,930	18,420	69,838	44,943	15,182
United States of America	9,850	25,766	5,270	11,138	24,348	5,475
Other foreign countries	99,230	76,824	38,554	38,085	44,855	24,714
British India	2,212,254	1,827,971	2,394,942	993,227	866,822	1,405,886
Other British Possessions	20	540	10	14	252	10
Total	3,488,457	2,885,364	3,109,939	1,702,943	1,510,233	1,897,326

The re-exports of whole and cleaned rice from the United Kingdom (foreign and colonial merchandise) for the years 1910–12, and their values, together with the principal countries to which the exports were consigned, are as follows:

	1910.	1911.	1912.	1910.	1911.	1912.
	cwts.	cwts.	cwts.	£	£	£
French West Africa	11,508	14,397	14,444	5,470	7,128	9,314
Portugal	11,160	13,448	39,801	5,043	6,439	23,668
Cuba	816,722	738,699	661,716	389,883	370,481	419,826
Brazil	57,436	30,481	28,791	33,420	21,465	25,437
Other foreign countries	107,715	134,221	197,090	56,241	71,376	124,916
British West Africa	91,920	82,223	73,186	44,175	41,698	45,379
Canada	32,747	30,368	20,960	14,603	15,760	13,742
British West Indies	198,706	193,376	136,236	93,235	98,178	77,220
Other British Possessions	23,874	19,393	24,731	12,594	11,381	17,257
Total	1,351,788	1,257,606	1,196,955	654,664	643,906	756,759

A relatively small quantity of rice is milled in England, and that mainly for export. The following table, taken from the *Annual Statement* above quoted, gives the quantities and values of rice, cleaned or milled in the United Kingdom, exported during the years 1910–12, and also the principal countries to which the exports were consigned:

	1910.	1911.	1912.	1910.	1911.	1912.
	cwts.	cwts.	cwts.	£	£	£
French West Africa	17,296	23,154	14,666	8,424	11,606	8,512
Portugal	18,154	23,206	18,710	9,591	12,610	12,066
Liberia	12,526	11,162	13,077	6,050	5,562	8,242
United States of America	35,764	36,855	28,856	17,717	20,664	18,345
Cuba	53,325	50,880	78,502	25,884	26,374	46,085
Brazil	84,399	51,890	44,224	41,421	28,533	28,913
Other foreign countries	145,917	133,274	139,837	74,785	69,038	85,519
Gold Coast	93,816	77,694	89,920	45,162	38,760	49,936
Southern Nigeria	174,988	166,498	143,234	86,411	83,560	83,033
Canada	36,873	42,377	45,296	21,233	26,019	34,526
British Honduras	15,669	18,804	15,437	7,604	9,296	8,733
Other British Possessions	109,016	82,063	38,770	54,444	41,929	23,080
Total	797,743	717,857	670,529	398,726	373,951	406,990

From the miller's point of view, in order to produce white rice of the finest quality, the first essential is a supply of good, bold grain of regular size. There is no economical method of grading large quantities of paddy according to size of grain, and when mixed samples have to be milled,

the large grains are frequently broken owing to their receiving too great pressure during the hulling and grinding processes, while the small grains escape milling.

The presence of unmilled and broken grains in a sample of "finished" rice lowers the commercial value of the latter considerably, and to eliminate them adds to the cost of production. Paddy or cargo rice always commands a higher price when the grains are uniform in size, and the necessity for keeping varieties distinct that differ in size or shape of grain is obvious.

The separated products obtained as a result of rice-milling are as follows:

"Head," "table," or "special" rice—consisting of whole grains of a uniform size.

Straights—mostly whole grains, but of a grade slightly below the preceding quality.

Screenings—broken rice, of which there are several grades, known as *smalls*, *points*, *brewer's rice*, and *fannings.* Broken rice is used for making ground rice or rice-flour, for brewing, starch-making, and other technical purposes.

Polish—a flour-like material (sometimes incorrectly spoken of as rice-flour) scoured from the surface of the grain during the polishing process. It is used as a cattle food.

Rice bran—consisting of the outer skin of the grain after the husk has been removed, together with the aleurone layer and the "germ." Used for feeding cattle.

Rice husks or hulls—the outer chaff-like covering of the paddy. It is used as fuel in the rice-mills, and as a packing material, but to a large extent is waste. Experiments have been made with a view to the utilisation of this product, and it has been mixed with crude petroleum and pressed into fuel-blocks; it has been suggested as a substitute for sawdust, and as a "filling" material in linoleum manufacture. In British Guiana it is mixed with molasses, and is exported as a cattle food.

The following percentage analyses of the products enumerated above are taken from Bailey's *Cyclopædia of American Agriculture*:

Product.	Proteins.	Ash.	Fat.	Carbo-hydrates.	Crude fibre.
Commercial or polished rice	7·52	0·73	0·38	78·05	—
Rice polish	11·06	8·45	5·92	65·97	—
,, bran	9·88	11·55	9·21	52·63	—
,, hulls	3·50	18·29	0·4	41·80	37·50
,, straw	3·31	14·64	0·59	33·31	32·01

The following table, taken from *The Agricultural Ledger*, 1908–9, No. 5, gives the average percentage results of the analyses of 159 samples of Indian rice:

Locality.	No. of Samples.	Water.	Proteins.	Fat.	Carbo-hydrates.	Crude fibre.	Ash.
Bengal	14	11·10	7·51	0·40	79·82	0·44	0·73
,,	12	12·37	7·09	0·40	78·86	0·48	0·80
E. Bengal and Assam	16	11·19	7·67	0·53	79·21	0·58	0·82
Burma.	10	11·54	7·54	0·98	78·59	0·58	0·77
Cuttack	11	10·92	6·58	0·31	80·81	0·35	1·03
Central Province.	7	9·05	6·68	0·88	82·05	0·42	0·92
United Provinces	10	10·03	7·44	2·83	77·14	1·00	1·56
Nepal.	13	11·28	7·50	0·85	79·13	0·32	0·92
Punjab	14	12·89	6·98	0·36	78·63	0·39	0·75
Bombay	16	12·61	7·69	2·65	74·63	0·89	1·53
,,	14	13·15	7·27	2·56	74·90	0·74	1·38
Madras	11	8·94	7·10	0·74	81·54	0·43	1·25
,,	11	11·69	6·81	1·03	79·00	0·49	0·98

Rice Production in the British Empire and Egypt

India.—It is estimated that about 35 per cent. of the cultivated area of British India is under the rice-crop. The principal rice-producing provinces are Bengal, Madras, Assam, Burma and the Central Provinces.

The total rice-crop for the year 1910–11 was estimated at 27,896,000 tons, and for 1911–12 at 26,099,600 tons, as against an average of 23,167,300 tons for each of the preceding five years. India exports more rice than any other country in the world. In the year 1911–12 the total quantity of rice exported amounted to 2,625,000 tons, valued at £19,371,000; of this quantity Burma contributed 73·6 per cent. Burma is less subject to crop disaster than are other parts of India; and as the rice area in Burma per head of population is 0·832 of an acre, as compared with 0·509 in Eastern Bengal and Assam, and 0·496 in Bengal, there is a larger surplus available for export. Burma rice is exported from Rangoon, and in the European trade "Rangoon rice" is now the standard, other descriptions being quoted in relation to it. Indian rice is mainly exported in the months

of January to April, and arrives on the western markets almost simultaneously with supplies from Saigon, Siam, and other sources. The result of this is a depression in price, owing to the market being glutted. For Java rice, which comes on to the market some six months later, much better prices are usually obtained; and this is, in a large measure, due to the smaller supplies on the market. In view of this fact, it has been suggested that modern grain elevators should be adopted in which to store the rice in Burma, and so spread the trade over a longer period of each year. (Cf. *Burma Rice*, by the Director-General of Commercial Intelligence, India, 1912.)

Ceylon.—Rice is the staple article of food of the native population in Ceylon, and the cultivation of rice is the principal industry of the village agriculturist. The total area under rice in 1910-11 was estimated roughly at 680,574 acres. A large part of this area depends entirely on the rainfall, and this renders rice cultivation somewhat precarious in some districts. The irrigation schemes at present being carried out by the Government will, it is hoped, render a larger area independent of the natural rainfall for rice cultivation. The local production of rice for the year 1911 amounted to 10,219,746 bushels of paddy, equivalent to 8,108,058 bushels of rice. The local output is, however, never sufficient to meet half the demand of the population, including the large number of immigrant coolies employed on the planting estates, and large quantities are annually imported. For the year 1911 the quantity imported to supplement the local supply amounted to 11,775,442 bushels of rice and 1,190,287 bushels of paddy. The bulk of the import comes from India.

Federated Malay States.—Rice cultivation is an important native industry in the Federated Malay States, but the country produces only a small proportion of the amount consumed locally. According to the *Report of the Director of Agriculture*, 1911, the area under rice for the year 1911-12 was 103,278 acres, as against 119,224 acres for the preceding year. The reduction in area was mainly due to the drought experienced in the early part of 1911, which continued over the planting season, and resulted in considerably reducing

the area planted in those districts dependent on rain. In 1912–13 the area under rice had increased to 122,751 acres. The yield of rice in 1912 was 2,645,134 bushels.

Large areas of flat, low-lying land in the Krian district of the State of Perak are now irrigated by the Krian Irrigation Works, the first extensive irrigation scheme undertaken by the Government in these States. Under this scheme, some 60,000 acres of land are irrigated, and in consequence the rice area in this district has more than doubled since 1904. Numerous river valleys throughout the States have been rendered suitable for rice cultivation by native systems of irrigation. In the Krian district the Department of Agriculture has recently issued rules regulating the planting of rice, and fixing a date by which all planting operations must be completed. This was necessary in order to facilitate the working of the irrigation scheme, but it is also hoped that it will reduce the damage done by insect pests by restricting the time during which fresh broods could arise. Experiments are being carried out by the Department with a view to improving the drainage of irrigated rice-lands and the native methods of cultivation. At Kuala Kangsar, seed selection experiments are now in progress, as a result of which it is hoped to improve the yield and milling qualities of the native varieties.

Fiji.—In Fiji the cultivation of rice is entirely in the hands of Indian immigrants, who cultivate the crop for their own food supply, but the local output does not meet the demand, and there is a considerable annual import. For the year 1912 the import of rice amounted to 2,376 tons, valued at £27,381, and this is likely to be considerably increased in the future, when the opening up of estates will result in the introduction of a larger rice-eating population. There are large areas of swampy land that might be rendered suitable for the production of lowland rice, and also drier areas at higher elevations suitable for the cultivation of upland varieties.

Australia.—In Queensland rice was successfully grown for some years, but during recent years it has been almost abandoned for more remunerative crops. In 1892–3 the

area under rice was returned at 1,113 acres, but this had fallen to 7 acres in 1908, whilst there was no record of the crop in 1909; in 1911, 15 acres were under rice.

In the Northern Territory there were 12 acres under rice in 1910–11, and 2 acres in 1911–12, but there are large areas of land suitable for rice cultivation available.

Egypt.—In Lower Egypt rice is cultivated chiefly in the Provinces of Sharqia, Behera, and Daqalia; in the north of Gharbia, especially near Damietta; and in Upper Egypt, chiefly in the Fayum. In the neighbourhood of Gharbia particularly it is grown for its own sake, but in other localities it is cultivated chiefly as a rotation crop with cotton, berseem, and wheat on lands that have become salty owing to imperfect drainage. The large quantities of water employed for the rice-crop, and the alternate draining and flooding that the crop receives during its growing period, tend to sweeten the land by removing the salts that are injurious to most other crops.

The area under rice for the year 1912–13, according to the *Annuaire Statistique de l'Égypte*, 1913, was 242,367 feddans (1 feddan = 1·038 acres), of which 229,150 were in Lower Egypt, and 13,217 in Upper Egypt. The varieties of Egyptian rice are grouped into three classes, according to the quality of grain and their periods of growth: "Sultani," a white grain of high quality, occupying the land for from 5½ to 6 months; "Yamani," white seeded, occupying the land for from 3½ to 4 months, and requiring little water; and "Sabeini," a dirty white grain, requiring much water, and occupying the land for only 2½ to 3 months. Two crops a year are obtained in Lower Egypt, and these are known as flood (nili) and summer rices. The former are sown in May, and the latter in August.

There is a considerable import and export trade in rice in Egypt, as is shown by the following table, taken from the source above quoted:

Imports of Rice

From	1910. *Kilos.*	1911. *Kilos.*	1912. *Kilos.*
British Possessions . .	30,554,788	34,821,091	33,825,492
Other countries . . .	10,357,782	3,662,683	516,729
Value	£E325,813	333,294	365,031

Exports of Rice

To	1910. Kilos.	1911. Kilos.	1912. Kilos.
Turkey	20,367,391	17,541,257	16,987,569
Other countries	8,446,519	12,214,557	8,154,567
Value	£E288,298	287,637	284,271

Sudan.—In the Sudan rice has been grown experimentally during the past few years in the Bahr el Ghazal Province, and in consequence of the favourable results obtained rice is now being grown to supply the troops stationed in that district. Experiments have also been conducted in the Upper Nile Province and in Southern Kordofan.

There is a considerable import of rice into the Sudan, the supplies being drawn chiefly from India, Egypt, and Italy. The import for the year 1912 amounted to 3,186,843 kilos, valued at £E28,683, as against 2,234,615 kilos, valued at £E17,829, in 1911.

Nyasaland.—It has been stated that a considerable quantity of rice is grown by natives at Kota Kota on the lake shore, and that the industry could be extended if a market could be found for the product in Europe. The prepared rice from Kota Kota is sold in Zomba at £5 6*s.* 8*d.* per ton, but it is thought that it could probably be produced on the marshes of the Lower River at from £3 to £4 per ton, which would bring the price in London to £5 10*s.* or £6 10*s.* per ton, allowing for transport at the rates now charged for maize. The unhusked rice could be exported at a cheaper rate. The total rice crop in the Protectorate in 1912 amounted to 824 tons, and the 1913 crop was estimated at 1,511 tons.

A sample of unhusked rice (paddy) and one of husked rice grown in Nyasaland were received at the Imperial Institute in January 1910. They were as follows:

No. 1. "Nyasaland paddy."—This consisted of clean, unhusked rice, from which the husk was easily removable, leaving rice grains, which were white, and of good plump appearance.

No. 2. "Nyasaland native-prepared rice."—This sample consisted of white rice, free from husk. The grains were rarely whole, although in most cases only small fragments had been broken off. The rice was covered with a

yellowish dust, which was readily removable on "polishing" in a soft calico cloth. The "polished" rice so prepared was of good appearance and colour.

The paddy was submitted for valuation to a firm of brokers, who stated that it would not interest millers in this country, and could only be sold here for feeding purposes at 5*s.* to 5*s.* 6*d.* per cwt. (March 1910), but that there is a demand for paddy on the Continent.

The brokers considered that the large proportion of broken grains in the sample of prepared rice diminished its value, but that consignments of similar character should realise 8*s.* to 8*s.* 6*d.* per cwt., packed in new bags, c.i.f. United Kingdom ports (March 1910). There would, however, be a better market for this rice in a partially cleaned condition, at 7*s.* to 7*s.* 6*d.* per cwt. (March 1910), as this quality suits millers better than more highly cleaned grain.

The brokers stated that the sample was extraordinarily mixed, and included grains having the characters of Java, Patna, Garden Siam, and Burma rice. They added, however, that the material would greatly interest millers in this country if properly prepared for the market.

Zanzibar and Pemba.—Zanzibar at present produces but little rice, and large shipments are annually imported from Rangoon. The hot, swampy valleys of the island of Pemba could be made to produce abundant crops of rice, but comparatively little is grown at the present time, although formerly rice was an important article of export.

The following eight samples of unhusked rice from Pemba were received at the Imperial Institute for examination in May 1912:

No. 1. "*Pemba Rice, Hill var.* (*Kikego*)."—This consisted of rice in the husk (paddy), the colour of which varied from light straw to pale brown. The length of the grains varied from medium to long, and the width from medium to broad. The rice was in good condition, clean, and free from extraneous matter. There were signs that the sample had been attacked very slightly by insects, and a small proportion of weak, discoloured grain was present.

On being husked and cleaned, the paddy yielded on the whole hard, fairly clear, translucent grain, of good

appearance, with a very slight yellow tint. About 30 per cent. of the grain had a red cuticle which could be removed by cleaning, yielding translucent or, in some cases, white, opaque grains. The husked grains measured from 6 to 7 mm. in length, and from 2 to 2·5 mm. in width.

No. 2. "*Pemba Rice, Valley var.* (*Sifala*)."—This consisted of rice in the husk, which was of pale straw colour; the grains were broad and of medium length. The sample was clean, of good appearance, and free from extraneous matter and insect attack.

On being husked and cleaned, it yielded for the most part moderately hard, fairly clear grains, translucent on the whole, though a considerable number were in parts white and opaque. About 20 per cent. of the husked grains had a red cuticle similar to that described in the preceding sample ("Kikego"). The cleaned rice had a very slight yellow tint. The husked grains averaged 6 mm. in length and 2·5 mm. in width.

No. 3. "*Pemba Rice, Valley var.* (*Sindano*)."—This sample consisted of rice in the husk, which was of a straw colour. The grains were long and slender in shape. The sample was in good condition, clean, and free from extraneous matter, but there were signs of insect attack, and a small proportion of weak, discoloured grain was present.

On husking and cleaning the rice yielded hard, clear, translucent grains, having a very slight yellow tint. The husked rice contained 2 per cent. of grain, having a red cuticle which could be removed by cleaning, yielding slightly opaque grains. The length of the husked grains was 7 to 7·5 mm., and the width 2 to 2·5 mm.

No. 4. "*Pemba Rice, Valley var.* (*Sena*)."—This consisted of unhusked grains, varying in colour from a straw tint to pale orange brown. The grains were broad, and varied in length from medium to long. They were in good condition, clean, and free from extraneous matter. The sample showed some signs of insect attack and contained a small proportion of weak grains.

The rice when husked and cleaned yielded hard, fairly clear grains of good appearance and of a very slight yellow tint. The husked rice contained approximately

4 per cent. of grains with a red cuticle, similar to those in the preceding samples. The length of the husked grains was from 6 to 6·5 mm., and the average width was 2·5 mm.

No. 5. "*Pemba Rice, Valley var.* (*Sifala ekundu*)."—This consisted of rice in the husk, mostly reddish-brown but in a few cases of pale straw colour. The grains varied in size but on the whole were rather thin. They were in good condition, clean and free from extraneous matter.

The rice when husked and cleaned yielded for the most part fairly hard, translucent grains of a slight yellow tint. The husked rice contained about 13 per cent. of red grains, which on cleaning yielded either translucent or white opaque grains. The average length of the husked grains was 6 mm., and the average width 2 mm.

No. 6. "*Pemba Rice, Hill var.* (*Halua*)."—This consisted of rice in the husk. The grains were rather short and broad, and of a pale straw colour. The sample showed slight signs of insect attack and contained a small amount of weak, discoloured grain, but it was clean and free from extraneous matter.

The rice when husked and cleaned yielded moderately hard grains, many of which were white and opaque on one side. A considerable number of translucent grains of a slight yellow tint were also present. The husked rice contained 7 per cent. of red grains, which on cleaning yielded chiefly white, opaque grains. The length of the husked grains was from 5 to 6 mm., and the width from 2·5 to 3 mm.

No. 7. "*Pemba Rice, Valley var.* (*Kibawa*)."—This consisted of rice in the husk, which was of straw colour and partially enveloped by two glumes. The grains were thin and of medium length. The sample was in good condition on the whole, but showed some signs of insect attack.

The rice when husked and cleaned yielded moderately hard, fairly clean, translucent grains. About 2 per cent. of the grains had a red cuticle, which could be removed by cleaning, yielding chiefly translucent grains. The length of the husked grains was about 6 mm., and the width 2 mm.

No. 8. "*Pemba Rice, Valley var.* (*Mzuri Wendo*)."—This consisted of rice in the husk, which was of a brown colour. The grains were medium to long, and of medium

width. The sample was free from extraneous matter, but it was slightly mouldy and showed signs of insect attack.

The rice when husked and cleaned yielded moderately hard, clear, translucent grains of good appearance. The length of the husked grains was from 6 to 7 mm., and the width averaged 2·5 mm.

As already mentioned, there is no market in the United Kingdom for rice in the husk, so that valuations of these samples, which were all in the husk, could not be obtained. Small quantities of sample No. 2, which may be regarded as fairly typical of the rest, were therefore husked at the Imperial Institute, and the husked grains submitted to two firms of merchants in London. One firm valued the sample at 10*s.* to 10*s.* 6*d.* per cwt. ex ship London (April 1913) and suggested that a small trial consignment should be shipped to London at an early date.

The second firm stated that the husked rice was suitable for the United Kingdom market and would realise about 10*s.* per cwt. delivered in bags in London (April 1913).

East Africa Protectorate.—Rice is grown by natives in all suitable places along the coast-belt of the East Africa Protectorate. Slight depressions in the land are usually taken advantage of in which to form the rice patch, as such situations retain rain water. In the Vanga district rice is grown on a considerable scale, the necessary water for irrigation purposes being obtained from the river Umba.

British West Africa.—On the west coast of tropical Africa rice is grown by native cultivators wherever conditions are suitable, but the local output has to be considerably augmented by imports in order to supply the demand. In Sierra Leone rice is the most important food crop, both swamp and upland varieties being grown. Most of the varieties are, however, of a red colour, and in consequence are of little value on the European market; but a certain quantity is exported to other West African countries, about 29,000 bushels of unhusked rice being exported to French Guinea in 1912.

Experiments with varieties of rice from South India, as well as with local varieties, have been commenced at the newly established Experiment Station at Jala.

Experiments are also being conducted at the Experimental Stations in the Gold Coast with a view to obtaining a variety suitable for local cultivation.

In Northern Nigeria the cultivation of rice is said to be extensively carried on in the low-lying districts to the south of Sokoto, where large areas of swampy land exist. It is possible to develop the cultivation of this crop in the valleys of all the large rivers. As large quantities of rice are annually imported at the Southern Nigerian ports, a ready market might be found for the crop.

THE PRESERVATION OF HIDES AND SKINS FOR EXPORT

The hides and skins obtained from animals slaughtered in the United Kingdom are not sufficient in quantity to meet completely the requirements of the home market, and large numbers are imported. The following table gives the quantities and values of the hides imported into the United Kingdom during the years 1910, 1911, and 1912:

Source.	1910.		1911.		1912.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
British Possessions.	*cwts.*	£	*cwts.*	£	*cwts.*	£
Australia	110,341	356,702	96,169	304,614	160,905	544,095
British India.	129,871	420,529	98,374	323,023	148,212	482,979
Cape of Good Hope	32,945	127,857	42,346	161,365	77,990	325,145
Natal	80,809	278,989	75,078	250,051	91,878	325,082
Straits Settlements	40,450	109,961	33,147	90,282	48,154	137,138
Other British Possessions	70,384	231,580	59,789	200,004	86,092	311,157
Total from British Possessions	464,800	1,525,618	404,903	1,329,339	613,231	2,125,596
Foreign countries.						
Argentine	123,807	447,993	187,020	684,564	211,844	833,997
Russia	89,379	284,762	64,758	228,400	223,257	758,782
Italy	130,700	478,233	76,544	287,433	105,428	399,006
France	61,792	223,504	71,656	229,870	93,569	317,905
Germany	85,139	251,506	48,260	148,250	60,974	191,587
Netherlands	47,974	151,120	37,131	112,917	43,671	147,506
Belgium	31,234	91,016	27,753	80,914	36,742	117,235
Other foreign countries	246,226	819,080	202,374	644,756	227,893	762,088
Total from foreign countries	816,251	2,747,214	715,496	2,417,104	1,003,378	3,528,106
Total from all sources	1,281,051	4,272,832	1,120,399	3,746,443	1,616,609	5,653,702

Such imported hides frequently have to wait some time, in many cases weeks or even months, between being flayed and being used by the tanner, and it follows that if they are to reach their destination in good condition and in such a state as to meet the requirements of the purchaser, they must be submitted to some process which will preserve them efficiently against putrefaction and attack by insects.

There are a number of methods in use for the preservation of hides, but many of these are unsatisfactory, the hide itself being sometimes damaged by the careless treatment it receives. Such dissatisfaction was felt with many of the methods in use for curing hides and skins that in 1908, at their Brussels Conference, the International Association of Leather Trades Chemists appointed an International Commission to investigate these methods and make recommendations for their improvement. The method which the Commission decided was most satisfactory is that known as the "wet-salted method." The skin while being flayed should be prevented from coming in contact with dirt or blood and should be allowed to fall into a basket or other receptacle, where it is left to cool. It is then washed thoroughly and afterwards drained to remove the excess of water. The skin should then be laid out flat on a clean floor or a suitable low table, flesh-side uppermost, care being taken that every part of the flesh-side is exposed. Salt is spread evenly over the whole area of the flesh-side and another hide, similarly treated, placed on top, and the process repeated until a pile about 4 ft. high has been raised. Each skin should be given a quantity of salt equal to 25 per cent. of its weight, and it should be seen that the top skin is well covered over. Where large numbers of hides are being treated, the piles may be built differently, but in whatever way it is done the hides should have plenty of salt. The skins are left in these piles until all the salt has been absorbed, which generally takes about a week, and should they not be "salt-firm," that is, free from excessive moisture, at the end of this period they are again salted. As soon as the skins are salt-firm they may be baled for transport.

In the case of wool skins, particular care should be taken

to prevent moisture coming in contact with the wool during the flaying process. In this case the salting is performed by laying the skins out flat after cooling and rubbing the salt into the flesh-side, then folding the skins from belly to belly and baling them for shipment in this state.

The salt used should be fresh, clean, common salt, free from material deleterious to the raw hide or likely to cause trouble in subsequent treatment, while in no case should old or previously used salt be employed. Anhydrous sodium sulphate may be substituted for the common salt and applied in half the quantity, that is, at the rate of 10 to 15 per cent. of the green weight of the skins. In countries where there is a Government royalty or tax on salt, this commodity is denatured before it is put to any industrial use, in order to avoid the payment of this impost. Many materials have from time to time been employed for denaturing salt, *e.g.*, alum, soda, tar products, petroleum, etc., but all have been a source of difficulty to the tanner, as they form undesirable combinations with the hide substance or cause stains. Recently elaborate experiments on a large and practical scale have been undertaken at the Royal Tanning School at Turin, at the instigation of the Italian Government, to discover a suitable denaturant. These trials showed that, provided the salt was pure, the addition of 10 per cent. of borax and 1 per cent. of naphthalene was successful, as was also the addition of 1 per cent. of naphthalene, 10 per cent. of sodium sulphate, and 0·017 per cent. of bichromate of potash. The value of the latter mixture for curing could be improved by the addition of 5 per cent. of borax.

Under certain circumstances, when it is desired to economise weight, and therefore cost of transport, it is more convenient to ship the hides in the dry state, and, should this be the case, they should be "dry-salted" if possible. The skins, after flaying, should be well washed, as in the previous method, and should then be hung up in a cool room or shed until partially dry. In this state they are spread on the floor and salted in piles, after which they are re-hung until they have acquired a soft but elastic condition, when they are re-salted. This method should

only be followed if it is not possible to keep the skins in the wet-salted state, since dry-salted skins are much more difficult to wash and soften for tanning. Probably, also, the crystallisation of the salt has a weakening effect on the fibre of the hide.

In some countries, where salt is dear, the distance of land transit great, and the means of transport primitive, it is only practicable to dry the hides, without salting them. In this case they should be well washed free from blood and dirt, and in the final washing some aromatic material, such as naphthalene, tobacco juice, or some similar product obtainable locally, should be added to the bath. The skins should then be hung up by the hind flanks or over poles, with the flesh-side outwards, in the shade, with a current of air circulating freely round each hide, and on no account should drying be done on the ground or in the sun. This drying ought to take place evenly and gradually, yet rapidly. If it is carried out too slowly, putrefaction sets in; while, if too rapidly, the hide cakes on the outside, and the inside is left moist and putrescible, and there is a strong probability that, in some parts, the fibrous structure will be destroyed and "blistering" will result. The sheds used for drying should be so constructed as to prevent the ingress of flies.

During the washing the skins may be treated with arsenic as a preventive of insect attack. Hides cured by this method, sometimes known as "flint hides," are always more difficult to soften than those preserved by the other methods described, and they command a lower price in the market.

Of the methods described, that in which the hides are wet-salted should always be employed when possible, as hides thus treated command a higher price than those cured by either of the other two processes. It is this method that is carried out on a large scale in the Chicago stock-yards for "packer" hides.

It is remarkable that, in view of the high prices which hides realise, more attention is not given to ensuring their arrival on the market in the best condition. It is generally true that the increase in the value of the hides will easily repay any extra care that may be taken in their curing,

provided that they have been flayed properly to begin with, and are not disfigured by prominent "brands," tears, or other marks.

UTILISATION OF CERIUM EARTH METALS AND THEIR COMPOUNDS

Recent developments in the technical use of the cerium metals for the manufacture of spark-emitting alloys furnish an example of the conversion of a hitherto practically useless product into a substance of considerable commercial utility.

The invention by Welsbach, in 1884, of the incandescent mantle for gas lighting led to a search for minerals containing thoria (see this Bulletin, 1905, **3**, 151 and 285), as this oxide is the principal constituent of these mantles. This resulted in the discovery of large deposits of monazite, the mineral now chiefly used as a commercial source of thoria, which it contains to the extent of about 5 per cent. Monazite also contains about 65 per cent. of rare earth oxides other than thoria, which may for convenience be called the cerium earth oxides, since ceria is the chief component, and which have been practically of no value up to the present. These oxides consist of about 45 per cent. cerium sesquioxide, 25 per cent. lanthanum oxide, 15 per cent. neodymium oxide, 7 per cent. praseodymium oxide, the rest being oxides of yttrium, samarium, etc. There have been accumulated at the various thoria works many thousands of tons of these hitherto unutilised cerium earth oxides.

In 1903, Welsbach found that the alloy, or mixture of metals, produced by the reduction of these cerium earth oxides, had pyrophoric properties, *i.e.* when struck or rubbed it had the property of emitting sparks. The production and use of such alloys he patented (German patent 154,807 of 1903; British patent 16,853 of 1903). At a later date it was found that the pyrophoric property of this mixture of metals was due to the presence of a superficial coating of oxides, which needed frequent renewal in order that the spark-emitting property should remain

unimpaired, and various patents were granted for methods of producing this active layer, such as heating the mixture of metals in a limited quantity of air. The necessity for such renewals was, however, disposed of by the discovery that alloys of this mixture of cerium earth metals with certain other metals, such as iron, nickel, cobalt, or manganese, possessed permanent pyrophoric properties. Thus, experiments showed that alloys containing from 10 to 65 per cent. of iron had these properties, but that the best proportions were 35 per cent. of iron with 65 per cent. of the mixed cerium earth metals, and at the present time many of the automatic lighters on the market contain spark-emitting material of this composition. Alloys of this type are now being made in Germany, the United Kingdom and Austria, the cerium earth metals being obtained by electrolysis of the anhydrous cerium earth chlorides. Many difficulties have been experienced in working this process owing to the fact that the mixture of cerium earth metals reacts easily with oxygen, nitrogen, hydrogen, and also other gases, such as carbon monoxide or dioxide, so that it has proved difficult to find a gas suitable for the production of an artificial inert atmosphere in which the operation of reducing these oxides to the metallic state can be conducted efficiently.

This alloy of iron with the cerium earth metals, which is often sold under the name of "Auer" metal, is hard and quite permanent in air.

Another pyrophoric alloy, patented about 1909, and known as "Kunheim" metal, consists of a mixture of hydrides of the cerium earth metals with magnesium and aluminium, and is produced by first alloying the cerium earth metals with magnesium and aluminium, then heating the alloy to a temperature of about 500° C. in an electrically heated muffle furnace in a current of dry hydrogen. By this means the cerium earth metals are converted into hydrides. The commercial product is stated to have the following composition:

	Per cent.		Per cent.
Cerium earth metals	85	Iron	0·5
Magnesium	10	Hydrogen	1·3
Aluminium	1·0	Silicon	0·5

It is interesting to note that whereas the hydrides of the individual cerium earth metals are unstable in air and lose hydrogen at a red heat, the mixture of hydrides is quite permanent in air, and at a fairly high temperature. "Kunheim" metal is lighter than the "Auer" metal, and is stated to be cheaper to produce.

A pyrophoric alloy, patented recently, consists of an alloy of manganese and antimony containing 5 per cent. of cerium earth metals. It is stated to be as efficient as those described above, and to cost much less to produce.

This new industry is said to be making rapid progress; in 1911 the output of "Auer" metal was given as about 10 tons, and, according to a recent statement, about 200 tons of the cerium earth oxides are now consumed annually for these purposes.

The general method of utilising these alloys as spark emitters is to cause a rotating piece of hard steel having a roughened edge to strike the alloy by means of a simple mechanism set in motion by pressure with the fingers, and so cause it to emit a shower of sparks, which ignite petrol or some other inflammable material on a piece of cotton wick. One kilogram (2¼ lb.) of the alloy is sufficient to make between 3,000 and 4,000 automatic lighters, and each of these is capable of giving from 2,000 to 6,000 separate ignitions. The introduction of these automatic lighters must have had a considerable effect on the match industry, and in such countries as France, where the manufacture of matches is a state monopoly, a tax has been imposed on these alloys, and on automatic lighters.

Numerous alloys of cerium with other metals have been described, but none of these are of technical importance at present. Cerium-mercury alloys are spontaneously inflammable in air, whilst cerium-magnesium alloys containing about 25 per cent. of the latter element can be readily powdered. Cerium earth metals are extremely reactive, reducing many metallic oxides with the evolution of much heat, and have been employed for the reduction of certain refractory oxides, such as those of niobium, tantalum, molybdenum, and zirconium.

Fluorides of the cerium earths are sometimes used,

together with calcium fluoride, as a constituent of "carbons" for electric flame-arc lamps. The effect of this mixture, which in some cases constitutes 70 per cent. of the whole carbon, is to increase the whiteness of the light. According to a recent statement (*Zeits. angew. Chem.* 1913, **26,** 806), about 300 tons per annum of the cerium earth oxides are used for this purpose. Cerium carbide has also been used to a small extent as a filament in incandescent electric lamps.

Many uses have been suggested for the cerium earths and their salts, *e.g.* in electrical accumulators, as a "contact" substance in the manufacture of sulphuric acid, and for photographic purposes. In medicine the cerium earth oxalates have been used to avoid or minimise nausea. Didymium salicylate has been used under the name of "dymal" as an antiseptic, non-irritant dressing for wounds.

In porcelain manufacture salts of neodymium are sometimes employed to give an amethyst-red colour, and praseodymium compounds to give a bright green. When about 1 per cent. of cerium oxide is added to potash glass a clear yellow colour is produced, which becomes brown when large quantities of ceria are used. "Didymium glass" has a fine blue colour, and is used for the production of coloured optical glasses.

Solutions of didymium salts are also used for branding trade names on incandescent gas mantles.

Numerous attempts have been made to utilise the cerium earth salts in the textile industry. According to one recent patent, yarn is treated with a solution of cerous chloride, having a specific gravity of 1·16 to 1·26; it is then dried, and passed through a strongly alkaline bath of sodium hypochlorite. After again drying it is woven with untreated yarn. If such cloth is dyed with a direct cotton dye, and then submitted to an acid bath, the yarn previously treated with the cerium compound loses its colour, thus producing a variegated pattern. With certain other dyes the reverse change occurs. Cerium salts have also been employed to some extent as mordants in leather dyeing.

GENERAL NOTES

Imperial Institute Handbooks to the Commercial Resources of the Tropics (Vol. iii., Rubber).—The third volume of this series of Handbooks, entitled *Rubber: Its Sources, Cultivation, and Preparation*, by Harold Brown, Technical Superintendent in the Scientific and Technical Department of the Imperial Institute, was published in February.

The aim of the book is to give, so far as is possible within the limits of 250 octavo pages, a general account of the subject of rubber production, including descriptions of the principal rubber-yielding plants and their exploitation in the wild or cultivated states. In accordance with the scheme of this series of Handbooks, considerable attention is given throughout to the rubber industry in British West Africa.

The first portion of the book is mainly devoted to a consideration of the general questions connected with the subject, such as the characters and composition of latex and rubber; the principles of tapping and the systems commonly adopted; the methods of preparing rubber; the chemistry of rubber; and statistics of production, consumption, and prices.

The principal rubber-yielding plants are then dealt with in some detail, separate chapters being given to the Para rubber tree (*Hevea brasiliensis*); the Ceara rubber tree (*Manihot Glaziovii*) and other species of Manihot; the African rubber tree (*Funtumia elastica*); the African rubber vines (*Landolphia* spp., etc.); the Central American rubber tree (*Castilloa elastica*); and the Assam rubber tree (*Ficus elastica*) and other species of Ficus. The rubber plants which are of less commercial importance than the foregoing are treated together in a general summary.

The book, which is illustrated by photographs, is published by Mr. John Murray, Albemarle Street, W., price 6*s.* net.

New Series of Selected Reports from the Imperial Institute.—In 1903 a volume of *Technical Reports and Scientific Papers*, containing the principal reports made by the Scientific and Technical Department of the Imperial Institute up to that date, was published. The reports made since then are now being published in the *Miscellaneous Series of Colonial Reports.* Parts I. and II., dealing respectively with Fibres, and Gums and Resins, were published in 1909 [Cd. 4588] and [Cd. 4971]; Part III., Food Stuffs, in 1910 [Cd. 5137]; and Part IV., Rubber and Gutta Percha, in 1912 [Cd. 6022]. Part V., dealing with Oil-seeds, Oils, Fats, and Waxes, has just been issued [Cd. 7260], price 8½*d.* The material dealt with in this part comprises both vegetable and animal products; the former are arranged under the headings, drying,

semi-drying, and non-drying oils, solid or semi-solid oils (fats), and waxes; the products of animal origin include fish oils and beeswax. In addition to well-known oils such as palm oil, ground nut oil, and castor oil, etc., a very large number of new or little-known oils suitable for the manufacture of paint, soap, or edible products, etc., are dealt with. In most cases where the seeds have been examined an account is also given of the feeding and manurial qualities of the cake or meal left after the extraction of the oil.

Agriculture in the Gold Coast.—The *Government Report on the Agric. Dept., Gold Coast*, 1912, contains an account of agricultural development during the year, together with reports on the separate agricultural stations and some notes by the Government Entomologist on various insect pests, principally those attacking cocoa, cola, and coconut trees. The cultivation of cocoa is still being extended. Considerable areas will probably soon be established with the "Cundeamor" variety (see this BULLETIN, 1912, **10**, 556), but the cultivation of this variety to the exclusion of "Amelonado," at present grown, is not recommended, as the latter is regarded as better suited to local conditions. Although a decrease of 2½ million pounds is shown in the exports of cocoa for 1912, as compared with those of 1911, the value was about £30,000 more, owing to higher prices ruling in Europe. The deficit in quantity is stated to be due principally to later ripening, as the harvest season extended into January; and the anticipation that an unusually large proportion of the crop will appear in the returns for 1913 has been realised, as, according to a cable received at the Colonial Office from the Gold Coast, the cocoa crop in 1913 amounted to the record quantity of 113,239,980 lb., valued at £2,484,218.

Exports of cotton amounted to 20,400 lb., valued at £500, but although this is fully double the amount exported in 1911, it is stated that cotton as a single cultivation cannot be profitable, and the native method of planting cotton in admixture with other crops is recommended. An account is given of experiments carried out at the Tamale station with varieties of cotton. Sisal and Mauritius hemps are also growing fairly well at this station. The quantity of cola nuts exported was the largest on record, being valued at £134,231. Very large quantities were taken into the interior, and are not included in the above figures. Exports of copra show a decrease of 150 tons, although the quantity is above the average. Exports of palm oil show a considerable decrease, although the quantity of palm kernels exported was the largest since 1902. The exports of rubber for 1912 show a very large decline, but native farmers are stated to be paying more attention to the planting of rubber trees on their cocoa farms, and Para

rubber seeds and seedlings are in great demand. Experiments have been carried on throughout the year at the Agricultural Stations on the tapping, etc., of different varieties of rubber trees, and on the cultivation of various crops, including coffee, ground nuts, foodstuffs, ginger, and tobacco.

The Agricultural Department of the Northern Territory of Australia.—The Northern Territory of Australia, which had previously been part of South Australia, was taken over by the Commonwealth Government on January 1, 1911, and on January 1 of the following year a Department of Agriculture was inaugurated. An account of the work of this department is included in the *Report* of the Administrator of the Territory for 1912, which was published last autumn. It is preceded by a historical account of agricultural industry in the Territory, from the time the first settlement was made on Melville Island, in 1825, to the present. Though the suitability of the land for certain crops was often demonstrated, very little was accomplished in pure agriculture; stock raising, however, made great progress until checked by the outbreak of redwater or tick fever in the eighties.

In 1911, sites for the establishment of demonstration farms were selected, and work on these has been commenced. The most advanced of these is at Batchelor on the railway about 60 miles from Port Darwin. It has a frontage on the railway of a little over a mile, and extends eastwards for 4 miles. It includes a variety of soils typical of the country, namely open forest land, a rich black soil which is swampy in the wet season, and stony ridges and hills affording dry stock-runs in the wet season. In the first year a great deal of preliminary work had to be accomplished, clearing the land, removing trees and their roots, fencing, and preparing the land for crops; and the necessary buildings had to be erected. Precise statements as to the cost of these operations are given for the guidance of future settlers. The main object of the farm is to demonstrate methods of stock raising and fattening with the aid of improved pastures and of fodder crops, so special attention was directed to the growth of the latter, and lucerne, sorghum, and cowpeas were found to do well.

The draught horses in the Territory are of very poor quality, so a Clydesdale stallion and 18 Clydesdale mares were imported from Victoria, in order to introduce a better type. Horses suffer much from the attacks of flies, so a large fly-proof stable is to be erected to protect them when not at work. Various dressings have been tried to repel the flies, and an emulsion of castor oil and washing soda has proved of some value and is coming into general use. Dairy cattle, sheep, pigs, and poultry have been imported.

The other demonstration farm is on the Daly River, and

is not so readily accessible, but by April 1913 a good start had been made. On this farm attention will be specially devoted to dairy farming and the crops it requires, and also to the growing of tobacco, sugar-cane, cotton, or other crops requiring intensive cultivation, since there are facilities for irrigation in the Daly District.

Government Inspection of Wattle Bark in South Africa.—The Government of the Union of South Africa have decided to undertake, from and after April 1, 1914, and until further notice, the inspection of wattle bark prior to its shipment from South Africa, and a Government notice embodying the conditions under which the inspection will be carried out has been issued (No. 2,032, December 23, 1913). A summary of these conditions is given below :

Each exporter who desires to have his bark inspected must previously complete an agreement with the Department of Agriculture, which will register his trade mark. All bark to be inspected must be packed in bags, each containing not more than 200 lb. gross weight. The official grades are as follows: H. 1, Heavy (first class); H. 2, Heavy (second class); M. 1, Medium (first class); M. 2, Medium (second class); T. 1, Thin (first class); T. 2, Thin (second class); B. G., Below Grade. Standards for the different classes of bark will be fixed by the Government, and the grading will be made in accordance with such standards. Every bag of bark submitted for inspection must contain on the sewn end the coat of arms of the Union of South Africa, followed by the grade mark, whilst the trade mark of the exporter must also be placed on the bag. Not less than 10 per cent. of a consignment will be examined by the inspector before a certificate is granted, and if any portion of the number of bags examined by him is found to be wrongly graded, he will grade it correctly and indicate the fact that it was found necessary to alter the grading on the certificate. For each bag of bark inspected, a charge of a halfpenny will be made to the exporter. Any exporter or his agent who is dissatisfied with any decision of the inspector as to the grading of the bark, may appeal to the appointed referee, whose decision shall be final.

It is hoped that the inauguration of this system of inspection will be in the best interests of the industry, and will prove to be of assistance not only to the shippers, but also to the European merchants dealing in wattle bark.

Cotton Seed Distribution in Egypt.—The Department of Agriculture in Egypt has realised that one of the best means of improving the cotton crop is the selection and distribution of good seed for sowing, and it has therefore devised a plan for carrying this into operation. The system consists of (1) the ordinary distribution scheme, under which good "Taqâwi" (*i.e.* seed for sowing as dis-

tinguished from "Tugari" or commercial cotton seed) is supplied to the small cultivators, and (2) the States Domains scheme, under which selected "Taqâwi" grown on the States Domains is supplied to the largest and most careful cultivators. A full account of both schemes has been published in the *Agricultural Journal of Egypt* (1913, **3**, 1).

In initiating the ordinary distribution scheme, it was necessary to bear in mind that the fellahîn, or native cultivators, are extremely improvident, and will purchase inferior seed on account of its cheapness, and that being in many instances in a needy state, they were compelled in the past to obtain their seed under the onerous conditions imposed by unscrupulous dealers. The Department therefore decided to supply the fellahîn with better seed than they had been obtaining hitherto, and at a more reasonable price and under less burdensome conditions. The seed is distributed on credit, and its cost is collected subsequently with an instalment of the land tax. It was also decided to restrict the distribution on credit to the fellahîn planting 8 acres or less, this being the predominating class of cultivators and the one most in need of the advantages afforded.

The scheme was started in 1910–11, when 1,570 ardebs (1 ardeb = 5·445 bushels) of seed were distributed in the Sharqîa Province. In 1911–12 the distribution was extended to the whole of Egypt, and the quantity of seed issued on credit amounted to 39,190 ardebs. During 1912–13 no less than 76,527 ardebs were distributed on credit to the peasant farmers. Nearly every village in Upper and Lower Egypt has been visited by special sub-inspectors, and the system of distribution explained. Applications for seed were received in 1912–13 from more than half the villages in the country. The seed supply is obtained from first-class ginners, who realise the importance of the project and the responsibility they incur, and consists of good Taqâwi (*a*) which the ginners provide from crops they have purchased, and (*b*) which comes from crops which have been inspected in the fields and are recommended by the Department's inspectors. Special arrangements have been made for bagging the seed and for inspecting the seed in the ginneries.

By means of the scheme outlined above, the Department of Agriculture is able to distribute much better seed than the growers could obtain otherwise. There is not at present, however, any highly selected seed available for extensive distribution, and steps are therefore being taken to introduce a pure type of seed in sufficient quantity to replace the deteriorated and mixed varieties now grown. This work is being carried out on the Department's experiment farms, but a considerable time must necessarily elapse before the results will be of practical utility to

the general distribution scheme. Meanwhile it has been decided that the States Domains seed should be adopted as a basis, this seed being recognised as the best obtainable in the country because of the great care which the States Domains Administration devotes to the cultivation and ginning of the crops. Arrangements have been made for a certain quantity of the seed produced on these estates to be placed each year at the disposal of the Department. This seed is distributed to the larger cultivators on condition that 50 per cent. of the seed resulting from its growth should be available for the use of the Department. This resultant seed is then sold to medium cultivators on the same condition, and the seed obtained from them enters into the ordinary distribution scheme for the smaller cultivators. To avoid confusion, the original seed from the States Domains is termed "Domains Taqâwi," the seed resulting therefrom (*i.e.* the second generation) "Domains Seed," whilst the seed resulting from the latter (*i.e.* the third generation) is known as "Domains Seed Fellâhi." By this means it is hoped that a well-organised scheme, to which all the cultivators will have become accustomed, will be in good working order by the time that the pure seed types which are being bred on the experiment farms by Mendelian methods become available for distribution. It is anticipated that in the course of two or three years there will be a sufficient supply of such seed to replace the Domains seed at present employed in the distribution scheme.

Caracul Sheep Breeding in German African Colonies.—The caracul sheep is of economic interest chiefly on account of the young lambs, which furnish the caracul or Persian lamb skins, which are valued highly for their curly black fur. These sheep are natives of Bokhara and neighbouring parts of South-western Asia, and are apparently of the same breed as the Astrachan sheep. The exact breed of sheep seems to be a matter of some uncertainty, as the published information refers loosely to caracul, Persian, or Astrachan sheep, without giving definite particulars which would enable distinctions to be made. According to the British consul at Bushire, Persia (*Natal Agric. Journ.*, 1908, **11**, 269), two distinct breeds are recognised in South Persia and Arabia, viz. the "Arabi" and the "Turki" or "Suri" breeds. The Arabi sheep are particularly hardy, are of heavier build, and yield better wool than the Turki sheep.

Prof. Wallace has stated (*Estate Magazine*, 1912, Nov., p. 657) that the breeding of caracul sheep has been taken up in many countries outside Persia; California, Eastern Russia, Germany, and German South West Africa being mentioned: and attention has been drawn by him to the possibility of establishing this breed in the United Kingdom.

Persian sheep have also been introduced successfully into Natal and other parts of the Union of South Africa, where they have been found valuable on account of their hardiness and capability of withstanding heat and drought. As far as can be ascertained little or no attention has been paid to the production of valuable lamb skins in the Union of South Africa, the sheep being used there as a source of wool and mutton.

An article has appeared recently (*Tropenpflanzer*, 1913, **17**, 593) giving some information about the breeding of caracul sheep in Germany and in German South West Africa, and also discussing the suitability of the breed for German East Africa.

Caracul sheep were first introduced into Germany in 1903, as being suitable for tracts of the poorest, sandy types of soil. Experiments have shown that both the pure-bred caracul sheep and crosses with several European breeds yield valuable lamb skins, and caracul sheep breeding is stated to have been taken up in several localities, although no information is given as to whether any appreciable number of skins have been obtained.

In German South West Africa, the first consignment of caracul sheep was received via Vienna in 1907. A second consignment, consisting of 251 ewes and 23 rams, obtained direct from Persia, reached Swakopmund early in 1909. These sheep have been used for the establishment of flocks, some being kept for experimental purposes at the Government farm at Windhuk, and the remainder supplied to farmers for breeding purposes. As it is almost impossible to obtain pure-bred caracul sheep in any large numbers, the pure-bred sheep have been crossed with the indigenous African fat-tailed sheep with satisfactory results. In April 1912 there were over 4,000 sheep in this colony, of which 341 were pure-bred caracul sheep, the remainder being half-bred. Skins of the half-bred lambs were valued at 4*s.* to 8*s.* each in Leipzig, but it is expected that much improvement will result from further breeding. The number of skins produced so far is not stated.

The method of establishing a flock is to pair a pure-bred caracul ram with thirty to fifty African fat-tailed ewes during October and November; the lambs are born in March and April, at the end of the rainy season, when the ewes have plenty of water and pasturage. The ram may be used for further breeding in March if strong and well-fed. The best of the male lambs may be killed for the sake of the skins, while the other males are used for fattening. The ewe lambs are kept and used when one and a half years old, at the earliest, for breeding; inbreeding being avoided by the introduction of new rams.

For the production of skins the lambs are generally killed when only five or seven days old, but are sometimes

kept for some weeks in Persia, being provided with leather coverings to prevent the wool from uncurling and becoming dirty. Great care is necessary in the preparation of the pelt: the skin, after being cleanly flayed, is carefully stretched out and dried in the shade; salting is not recommended, but naphthalene may be used as a preservative. The flesh of the flayed lambs may be used as food, while the ewes' milk may also be turned to account for cheese making.

In German East Africa certain high-lying tracts of land, *e.g.* those between Kilimandjaro and Lake Nyasa, are considered promising for caracul sheep, but no industry appears to have been established there yet.

Under suitable conditions the breeding of caracul sheep appears to be profitable, as the sheep are hardy, and cross readily with other breeds. The lamb skins vary very much in value according to quality; a firm in Leipzig dealt with 385,000 skins in one year, the average price being about 16s. each; fine-quality skins may fetch 60s., and even more than this is paid for fancy qualities. The introduction of this breed of sheep into British colonies where climatic conditions are favourable is worth careful consideration.

Mining Law in Nigeria.—The Governor of Northern Nigeria recently issued a Minerals Proclamation, entitled *A Proclamation to regulate the right to search for minerals and also to dig for, mine and work minerals, and also for other purposes relating thereto.* It is dated November 26, 1913, and came into operation on December 2, 1913.

According to this proclamation, a prospecting right entitles the holder to prospect for one year in those parts of the Protectorate which are not included in any mining lease or exclusive prospecting licence, and which the Governor has not by notice in the *Gazette* declared to be closed to prospectors or reserved from prospecting. The fee to be paid for this prospecting right is £5. The applicant for a prospecting right must, if required by the Governor to do so, show that he possesses sufficient money or credit to enable him to carry on his work, and a credit of £100 with a local bank will usually be required for this purpose.

An exclusive prospecting licence entitles the holder to the sole right of prospecting for minerals within an area not less than one square mile, and not more than sixteen square miles in extent, and for a period of one year, subject to renewal, at the discretion of the Governor, for further terms of one year each up to three years; provided that the area or any part of the area, formerly subject to an exclusive prospecting licence which has lapsed, shall not be the subject of the issue of another exclusive prospecting licence. Under certain conditions the Governor may grant a renewal for a fourth year. The rent to be paid for an

exclusive prospecting licence is £5 per square mile per annum for any period up to three years, and £12 10*s.* if renewed for a fourth year.

The preliminary fee for the survey of an area held under an exclusive prospecting licence is £15 per area, provided that where two or more areas are in close proximity the fee may be reduced at the discretion of the Director of Surveys. In addition to this, the fee for the survey of a boundary is from £3 3*s.* to £5 5*s.* per mile or part thereof, according to the character of the country surveyed.

An applicant for a mining lease must hold a prospecting right or an exclusive prospecting licence, and no lease can be transferred without the consent of the Governor. A mining lease may be granted for any term not exceeding twenty-one years, and if the work is satisfactory the lessee will be entitled to renew the lease for a further term not exceeding twenty-one years. Mining leases are classified as (*a*) lode mining, (*b*) alluvial mining, (*c*) stream mining, (*d*) iron mining, (*e*) carbonaceous minerals, (*f*) earthy minerals, (*g*) water power, and (*h*) dredging leases.

The royalties to be paid by holders of mining leases may be collected in the form of an export duty. The royalties fixed up to the present are: For tin ores and metallic tin, 5 per cent. of the value until the railway has been declared open to Naraguta, and after that 7½ per cent.; on lead ores or metallic lead, containing on an average less than 4 oz. of silver per ton, 2 per cent. of the value, and if containing more than 4 oz. of silver per ton, an additional 3 per cent. on the value of the silver; on iron ores or metallic iron, 1 per cent. of the value.

Many other matters of importance to prospectors and mine owners are dealt with in the proclamation. One noteworthy clause compels every employer of native labour in connection with mining or prospecting operations to pay each labourer personally and individually in cash monthly (or at shorter intervals) the total amount of the wages due to him without deduction. The payment is to be made in the presence of a responsible officer and certified by him. If an employer has recruited labourers from a distance he must either repatriate them by train or otherwise or provide them with reasonable maintenance and transport allowance for the journey to their homes.

Another document that has been issued recently with reference to the mining industry of Nigeria is the *Minerals (Amendment) Ordinance*, Southern Nigeria, dated December 3, 1913, and published in the *Southern Nigeria Government Gazette* for December 17, 1913.

Mineral Production of India.—In his annual report on the mineral production of India during 1912 (*Rec. Geol. Surv. India*, vol. 43, part 2, 1913), the Director of the Geological Survey reports a considerable increase in the mineral

output. The value of the total output for 1912 was £9,321,486, which exceeds that for any preceding year, and is over a million and a quarter sterling in excess of that for 1911, an increase of nearly 17 per cent. The chief items of the output value for 1912 are shown in the following table:

	£	Percentage variation on output for 1911.
Coal	3,310,365	+ 32·3
Gold	2,271,806	+ 1·5
Petroleum	975,278	+ 10·3
Manganese ore	884,404	+ 36·3
Salt	509,824	+ 8·6
Mica	284,290	+ 50·7
Building materials, etc.	270,980	+ 10·0
Saltpetre	217,035	− 1·5
Lead ore and lead	153,069	− 15·9
Tungsten ore	115,200	+ 15·2

Other items of considerable note are corundum (chiefly gem varieties), clay, iron ore, tin ore, monazite, copper ore, silver, and jadeite. The less important minerals include magnesite, chromite, alum, steatite, garnet, gypsum, bauxite, diamond, platinum, amber, ochre, and samarskite.

The large increase in the total value of the coal output was due partly to an increase in price. The tonnage increase was nearly 16 per cent. over that of the previous year, whereas the increase in total value was 32·3 per cent. As usual, the Gondwana coalfields contributed nearly the whole output, the amount mined in these fields being 14,298,083 tons, compared with 408,256 tons obtained in the Tertiary coalfields.

Both in Orissa and Singbhum there was a considerably increased output of iron ore, and the rise in value of the output, from less than £10,000 in 1910 to nearly £50,000 in 1912, is attributed to the activity of the Tata and Bengal iron and steel companies.

A drop in the value of the jadeite output, from £41,660 in 1911 to £10,800 in 1912, is attributed to the disturbed condition of China and consequent restriction of trade, China being the chief purchaser of Burmese jadeite.

A notable feature, that is rather out of harmony with the general progress of Indian mining during 1912, was the discontinuance of graphite mining. Graphite had been mined for some time in Travancore, and the output, which had a value of over £20,000 in 1910, dropped to £9,425 in 1911, and ceased altogether in 1912.

Reference has already been made in this BULLETIN (1913, **11**, 609, 702) to the increased output of tungsten ore and monazite in Burma and Travancore respectively during 1912.

Mineral Production of New South Wales.—*The Annual Report of the Department of Mines, New South Wales, for the year*

1912 puts the total value of the mineral production for that year at £11,641,435. This is an increase of £1,883,428 on that for the previous year, and a record output for the State, being £1,064,057 in excess of that for 1907, which was the previous best year. This result is attributed to highly favourable prices for metals, the absence of serious labour disputes, and a marked expansion in the coal trade. The chief items are as follows:

	£	Variation from previous year. £
Coal	3,660,015	+ 492,850
Silver and silver-lead, etc.	3,745,796	+ 1,093,248
Zinc	1,766,242	+ 351,262
Gold	702,129	− 67,224
Copper	579,791	− 10,311
Portland cement	368,280	+ 52,711
Tin	338,074	+ 30,985
Lead	264,530	+ 54,746
Iron	130,708	− 14,708

Other items in the output include opal (£35,008), oil shale (£34,770), wolframite (£16,584), alunite (£13,700), scheelite (£4,963), platinum (£3,880), molybdenite (£3,706), diamonds (£2,001), bismuth ore (£1,210), and antimony ore (£355).

The output of silver-lead was the largest on record, chiefly from the Broken Hill mines. In this connection the considerable increase in zinc ore, which is exported in the form of concentrates, is also notable.

With reference to the diminished gold output, it is remarked that prospecting for this metal has been neglected owing to the remunerative employment offered by other branches of the mining industry.

Although the copper output decreased on the whole, there was an increased production at the mines in the Great Cobar District, and one of the features of the year was the re-opening of the Lloyd copper mine, which had been closed down since 1909 owing to the difficulty of obtaining fuel.

The greater portion of the tin output was, as usual, obtained by dredging. The tin-ore dredges recovered 1,626 tons of stream tin, valued at £223,813, which is £15,718 in excess of the previous year's production. The most successful results were secured by the dredges in the Emmaville Division, the output there being 744 tons, valued at £101,943.

There was a diminution in precious opal and diamonds. As in the previous year, the diamonds were obtained only from the Copeton district, where they are obtained from the alluvial workings, though pipe formations at Oakey and Staggy creeks were actively prospected.

Platinum mining was carried on throughout the year at Platina, in the Fifield Division. The deposits were worked to a depth of about 60 ft., and the proportion of the associated metals, so far as could be ascertained, varied from 4 to 8 parts of platinum to 1 of gold per load.

The value of the alunite output, which was obtained wholly from Bullahdelah, was £9,905 in excess of that for the previous year.

An Electrical Process for the Purification of Clay.—An interesting process, originally invented by Count Schwerin, which may prove to be of considerable technical importance in the treatment of low-grade clays, has been described recently by Dr. W. R. Ormandy (*Trans. English Ceramic Soc.* 1913, **12**, 36). In the process usually employed for preparing clay, the raw material is made into a thin "slip" with water, and the heavier and coarser impurities are allowed to settle out. This treatment is not always effective when the impurities are present in a finely divided state, and the new process is stated to be particularly suited for the purification of material of this character. The raw clay, as dug, is made into a "slip" with water, and to this is added a very small quantity of a suitable electrolyte. This addition causes the "slip" to deposit immediately the greater proportion of its solid impurities, but the clay remains in suspension and cannot be recovered either by allowing it to stand or by filtration. Most clays, when suspended in this manner, have strongly electro-negative properties, whilst the impurities, such as the oxides of iron and titanium, are mostly electro-positive, and the free silica behaves as a nearly neutral substance. Advantage is taken of these properties in the next stage of the process. After allowing the mixture of "slip" and electrolyte to stand for one to three hours, in order to allow the coarser particles of the impurities to settle out, it is next run through the "Osmose" machine. This latter may be briefly described as a semi-circular trough in the centre of which is a revolving metallic drum serving as the anode. Under this drum, and distant from it about half an inch, is the cathode, which consists of a wire screen. The clay "slip" passes between these electrodes and is subjected to a direct electric current of 60 to 100 volts. This treatment causes the clay substance to collect on the slowly revolving anode, and the impurities to attach themselves to the cathode, from which they are removed by means of a continuous worm. As the inner cylinder slowly revolves the clay substance comes away, at the top, in the form of a continuous blanket, 1·5 yd. wide, and about ¼ in. thick.

The clay, as it leaves the "Osmose" machine, contains from 18 to 30 per cent. of water, the amount depending largely upon the voltage of the electric current used: within certain limits, increase in voltage causing a decrease

in the amount of water retained by the clay. The improvement in the quality of the clay may be illustrated by selecting, from the numerous examples quoted in the paper, the case of a Dudley fire-clay. The "Osmose" treatment raised the melting point of the material from Seger cone 34 to 35, but lowered the sintering temperature by nearly 300° C. The purified clay, when burnt, was in point of colour equal to a good ball clay. The percentage of alumina, calculated on the ignited product, was raised from 39 to 44 per cent.

The effect of varying the time of settling is shown by the behaviour of a Hedwigsfreude clay, which, after standing for one hour, gave a final product containing 40·46 per cent of alumina (calculated on the ignited material). When allowed to stand for three hours this percentage was raised to 43·75, and fourteen hours' standing gave a product containing 45·57 per cent. Thus it is seen that the quantity of silica left in the final product can be adjusted to suit the potter's requirements.

Amongst the other advantages claimed for this process over the older methods, the following may be mentioned. In many cases the yield of purified clay is increased, the space occupied by the plant is considerably less, and the consumption of water is largely reduced.

The cost of the electric current necessary for the above treatment is stated to vary from 4*d.* to 2*s.* 6*d.* per ton of finished product, according to the nature of the clay. An average estimate, however, may be taken as 1*s.* 6*d.* per ton, if the electrical energy can be obtained at ½*d.* per unit. The plant necessary for producing 40 tons per day of clay, containing 30 per cent. of water, is stated to cost about £5,000.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports published during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India, and the Tropics generally.*

AGRICULTURE

Soils.—In *Bulletin* No. 6, *U. S. Dept. Agric.* (The Agricultural Utilisation of Acid Lands by means of Acid-tolerant Crops), attention is called to the fact that one of the chief sources of acidity in soils is decaying vegetable matter, and it is shown that the acidity of one acre of alfalfa (estimated at 2·5 tons of dry material) requires 267 lb. of limestone for its neutralisation. Although crops

which require their nitrogen in the form of nitrates are not a success in acid soils, owing to the fact that nitrifying bacteria cannot thrive in acid media, there are certain crops which grow well in soils of this character, and which possibly obtain their nitrogen by other means. Amongst these are the whortleberry, cranberry, strawberry, blackberry, raspberry, potato, rye, oats, millet, sweet-potato, buckwheat, maize, carrot, and turnip. When a green manure is required for use on acid soils, use can be made of the cowpea, soy bean, or hairy vetch.

The saline nature of the soil water of the estates on the coast of British Guiana is stated to have caused considerable trouble in the cultivation of sugar-cane. Experiments have shown that the saline matter is absorbed by the plant during growth, with the result that the juice contains an excessive amount of mineral matter which forms compounds with the sucrose. M. Bird (*Journ. Indust. and Eng. Chem.* 1913, **5**, 1012) found that the soil waters contained a large amount of magnesium salts. As the lands are often below sea-level, these waters cannot be removed by drainage, and so the experiment was tried of dressing the land with slaked lime, at the rate of 2 to 3 tons per acre. It is stated that this treatment caused a marked improvement in the quality of the juice from sugar-cane subsequently grown on the land.

Foodstuffs and Fodders

Cocoa.—A useful note entitled "The Practice of Cacao Fermentation," by Arthur W. Knapp, has been reprinted from *Tropical Life*. The author visited a considerable number of plantations in Trinidad and Grenada, and, as a result of his observations on the methods adopted there, gives a number of suggestions for obtaining a good fermentation. An account is given of a method for fermenting small quantities of beans, and the results of an experiment are quoted which show that it is not the size of the fermenting box, but the amount of protection from cooling, which determines the temperature of the fermenting beans and their degree of fermentation.

Elephant Grass.—An account of this grass (*Pennisetum purpureum*) as a paper-making material was given in this Bulletin (1913, **11**, 68). New observations on the utility of the plant as a fodder are published in *Rhodesia Agric. Journ.* (1913, **10**, 833). It has been found to keep green throughout the winter months in Salisbury, and provides an excellent, succulent green fodder for cattle during that period. During the season 1912-13 an experimental plot was cut twice, yielding respectively 12 and 15 tons of green fodder per acre. Under poor conditions, such as dry situation, red or sandy soil, and a cold climate, elephant grass is regarded as being superior to sugar-cane as a fodder plant. Under

better conditions of soil and climate, the latter is likely to give equal or better results. In damp situations elephant grass wilts and is best replaced by Paspalum.

Sudan Grass.—*Circ.* No. 125, *Bur. Plant Indust., U. S. Dept. Agric.*, contains an account of this drought-resistant fodder plant. The seed was obtained from the Sudan in 1909, where the grass grows wild, being known as "Adra," and is cultivated to a small extent as "Garawi." The Sudan plant has hitherto been classified as *Andropogon halepensis*, but the United States authorities regard it as a variety of *A. sorghum*. Trials at numerous places in the United States have demonstrated that this grass promises to be of great value in semi-arid regions. Under somewhat more humid conditions it surpasses foxtail millets, producing more and better hay. Individual plants under favourable conditions grow to a height of 10 ft., and may possess twenty or more stalks about the thickness of a pencil. When sown broadcast or in drills the height averages 3 to 4 ft., the stalks are finer, mostly unbranched, erect and leafy. The grass is stated to be very palatable, but until the feeding trials have been completed no definite statement as to its feeding value can be made.

Oils and Oil Seeds

Candle Nut Oil.—Results of the examination of this oil, obtained from the nuts of *Aleurites triloba* (= *A. moluccana*), known in Hawaii as the kukui tree, are given in *Journ. Indust. and Eng. Chem.* 1913, **5**, 644 (cf. this Bulletin, 1907, **5**, 135). It is stated that the cake cannot be used as a fodder, as it has a poisonous effect on cattle.

Aleurites triloba is known in the Philippine Islands as "Lumbang" (*Tropical Life*, 1913, **9**, 214). Owing to the valuable drying and other properties of the oil, it is in great demand, but producers in the Philippines are unable to accept orders from foreign merchants, since the supply of nuts is uncertain and the mills are for the most part small and antiquated. It is suggested that Philippine planters should endeavour to develop the trade in this oil by systematic plantation of the trees.

Castor Seed.—According to *L'Agronomie Coloniale* (1913, **1**, 15) there is scope for greatly extended cultivation of castor seeds in Senegal and the French Sudan. Hitherto planters have been handicapped by lack of suitable transport facilities. Results are given of the examination of various samples of castor seed from French West Africa.

Coconuts.—The cultivation and manurial requirements of coconut trees in the Seychelles are discussed by Dupont in *L'Agric. prat. des pays chauds* (1913, **13**, 345). Two kinds of soil exist in the Seychelles, the first formed by disinte-

gration of granitic rocks, the second a coral-sand soil, in both of which potash and nitrogen are deficient. The coralline soils common in the outlying islands contain phosphates derived from bird guano and are very fertile, but require the application of potassium sulphate. On the granitic soils the application of a ton of guano per hectare every five or six years, and 100 lb. of potassium sulphate every year, should suffice for coconuts. Guano is readily obtainable at Victoria, while potassium sulphate is obtainable at Colombo for 185 rupees per ton, and is cheaper per unit of potash than kainit. The granitic soils also require lime to neutralise acidity. The cultivation of leguminous crops as a source of nitrogen is recommended.

A general article on the coconut beetles, *Oryctes rhinoceros* and *Rhyncophorus ferrugineus*, is published in the *Gardens Bulletin*, *Straits Settlements* (1913, **1**, 176). The occurrence of these beetles in the principal coconut-growing countries is described. Particulars are given of the methods employed for destroying these pests, and the provisions of the local Ordinances against them are summarised.

In the Solomon Islands 25,000 acres are now planted with coconuts, excluding native plantations (*Colonial Repts. Ann. Series* [Cd. 7050–15], 1913, p. 16), but there is a scarcity of labour. The methods of planting differ from those employed in the eastern plantations, where the young plants remain for a year or more in the nursery; it is considered better in the Solomon Islands to transplant much sooner, in fact before the rootlets have pierced the husk, in order to avoid damage to the young roots.

The leaf-eating larva of a beetle (*Brontispa Froggatti*) caused a good deal of damage formerly, but does not seem to have been much in evidence during recent years. Attempts were made to eradicate the beetles by importing Australian magpies and Indian mynahs to eat the beetles, but these birds do not appear to have increased to any great extent; treatment with insecticidal washes has been employed with greater success. Two species of boring beetles, *Xylotrupes nimrod* and *Trichogomphus semelinki*, have also caused some damage, and it is suggested that flamboyant trees (*Poinciana regia*), to which the beetles are attracted, should be planted. The bud-rot disease is stated to have occurred in one or two places, but the effects of lightning may have been mistaken for this disease. In the preparation of copra, kiln-drying will probably replace open-fire drying altogether in the future in the islands.

The use of a mixture of kerosene and tar in place of tar alone is recommended for destroying boring-beetles on coconut palms (*Trop. Agriculturist*, 1913, **41**, 188), as being easier to apply owing to its greater fluidity.

Oil Palm.—The Commercial Intelligence Officer for Southern Nigeria has collected the following information regarding the working of the oil palm by natives in that colony (*Nigerian Customs and Trade Journal*, 1913, **3**, 360). Palm kernels are fully worked in many districts and an increased production can only be obtained by further planting. In districts where the kernels are not exploited fully it is suggested that transport facilities should be improved, and that nut-cracking machines should be introduced. Palm oil is used as food in almost all the districts, from about 2 to 8 gallons per head per annum being the usual amount, but in two districts the consumption is stated to be 20 and 28 gallons respectively. Palm kernel oil is made in a number of districts, but the kernels do not appear to be used as food to any appreciable extent. Canoes seem to be lacking in a number of districts, with consequent hindrance to transport.

The results of further investigations on the oil palm in the Misahöhe district, Togoland, are given by Gruner in *Der Tropenpflanzer* (1913, **17**, 353). The annual yields of palm fruits in a plantation are being recorded, but these records have not been kept long enough for any conclusive results to be obtained. The yields for the first seven months of 1912 are somewhat low, about 22½ lb. of fruit per tree ("Ede" variety) being obtained, probably owing to the excessive drought of the preceding year. Diagrams correlating the rainfall and yearly output of oil and kernels show that an increased output generally follows for one or even two years after a year of high rainfall.

Sesamum Seed.—Owing to exceptional rains in Kordofan, exports of sesamum from the Sudan in 1912 were greater by 1,000,000 kilos. than in 1911. High prices were paid, and it is stated that the cultivation of sesamum in the Sudan should increase with the extension of irrigation (*Annual Report Cent. Econ. Bd. Sudan*, 1912, No. 6, p. 42).

Miscellaneous.—The seeds of *Dilobeia Thouarsi*, Roem. and Schult. (N.O. Proteaceæ), a tree occurring in Madagascar, contain 64 per cent. of a yellow oil, which at normal temperatures deposits a quantity of solid white "stearin" (*Journ. d'Agric. trop.* 1913, **13**, 250): it is stated that the thick shell of the seeds would render them unsuitable for commercial exploitation.

The results of the examination of seeds of *Carya amara* or swamp hickory and *C. ovata* or shellbark hickory are given in *Journ. Indust. and Eng. Chem.* (1913, **5**, 739). Kernels of *C. ovata* contain about 70 per cent. of oil. By cold pressing, followed by hot pressing, a yield of nearly 50 per cent. of oil was obtained. The oils from both varieties of nuts give very similar analytical con-

stants, closely resembling those of cotton-seed oil. They possess an agreeable hickory nut flavour, and could be used as edible oils. At present the nuts from *C. amara* are considered valueless, and are fed to pigs; it is suggested that the possibility of manufacturing the oil on a commercial scale should be further investigated.

Decorticated seeds of *Jatropha mahafalensis* contain about 60 per cent. of oil (*Journ. d'Agric. trop.* 1913, **13**, 250). By pressing, 44 per cent. of a mobile, amber-coloured oil is obtained, which has an iodine value of 112 per cent.

Mafureira seeds (*Trichilia emetica*) are becoming better known in Europe, and a good demand has been met with from Marseilles soap manufacturers (*Dipl. and Cons. Rep.* No. 5,210, 1912 [Cd. 7048–26]). The exports from Portuguese East Africa in 1912 are estimated at 2,000 tons, the value at Marseilles being £11 per ton c.i.f. (cf. this BULLETIN, 1911, **9**, 406).

Investigations of the fruits and seeds of *Mimusops Djave* seem to show that there is no poisonous constituent present (*Der Tropenpflanzer*, 1913, **17**, 399), but the question of the toxic action of the seeds is still left open, since the age of the tree is said to exert some influence on the nature and quantity of the glucosides present.

According to the *Board of Trade Journal* (1913, **83**, 308, 425) a factory is shortly to be opened at Sandefjord, Norway, for the purpose of hardening whale oil by a new Austrian process which differs from that adopted by the Fredrikstad company (see this BULLETIN, 1913, **11**, 663). The company will have the sole right in Norway of working the Hydrier method of hardening and treating oils and fats; and is arranging for an annual output of from 12,000 to 15,000 tons of the finished product.

ESSENTIAL OILS

Ocimum spp.—Oils derived from two species of Ocimum, and prepared at Dabakala, Ivory Coast, have been examined by Roure-Bertrand Fils (*Bulletin*, October 1913, p. 17). The oil of *Ocimum canum*, Sims (*O. americanum*, L.) was at ordinary temperatures a crystalline mass, owing to the separation of methyl cinnamate, which constituted about 87 per cent. of the oil. The liquid portion of the oil was composed apparently of hydrocarbons, and gave an optical rotation of $-3° 24'$. The oil of *O. gratissimum*, L., was golden-yellow in colour, and possessed an odour resembling that of ajowan seed oil. The specific gravity was 0·9105, and optical rotation $+0° 58'$. It contained 44 per cent. of phenolic constituents, consisting almost entirely of thymol. In this respect the oil resembles that of *O. viride*, Willd., a sample of which, examined at the Imperial Institute, contained 32 per cent. of thymol (see this BULLETIN, 1908, **6**, 209).

Cyprus Origanum Oil.—The *Cyprus Journ.* (1913, No. 31, p. 717) mentions that experiments on the cultivation of the Cyprus origanum plant are now being conducted by the Agricultural Department. A brief statement is given as to methods of cultivation. Owing to its strong antiseptic properties (this BULLETIN, 1910, **4**, 407, and 1913, **11**, 50), there is a good demand for this oil; the price in England was stated to be more than 12*s.* per oke (2·8 lb.) in 1912. It is estimated that, after the first year, a yield of about 40–60 okes of the oil would be produced annually per Cyprus scala (1,600 sq. yds.).

RUBBER

Funtumia elastica.—According to the *Ann. Rept. Forest Administration Southern Nigeria for* 1912, trees in the Ibadan and Mamu reserves were tapped by the half-herring-bone system to a height of 20 ft. on half the circumference; 3,501 lb. of dry rubber were obtained, including 66 lb. of scrap, the first-quality rubber being sold locally at 3*s.* 10*d.* per lb. In the Central Province 38,147 trees of 18 in. girth and over were tapped, but an average yield of only 1·138 oz. per tree was obtained; most of the rubber obtained sold locally at 3*s.* 4*d.* per lb.

Hevea brasiliensis.—The advantages of the basal or single V system of tapping are pointed out in the *India-Rubber Journ.* (1913, **46**, No. 26, p. 19). This method has been proved to give high yields of rubber, and is now being employed on practically all the estates in the northern part of Malaya. Four years are allowed for bark renewal. As the tapping is not extended above 3 ft. from the ground, children can be employed, and 400 to 450 trees can be tapped per diem by one tapper. It is stated that less scrap rubber is produced by this system than by the quarter or half-herring-bone systems.

Attempts are being made to improve the methods of preparing Para rubber in the Amazon rubber districts by the introduction of a simple apparatus for coagulating the latex (*Journ. d'Agric. trop.* 1913, **13**, 329). The apparatus consists of an easily portable aluminium drum designed to take the place of the wooden paddle or pole employed by the "seringueiros"; the method of coagulation consists in applying the latex to the surface of the drum, which is then exposed to smoke in the usual manner, the process being repeated until a sheet of rubber from $\frac{1}{8}$ in. to $\frac{1}{5}$ in. in thickness is obtained; the sheet is then removed from the drum and dried. The rubber produced is said to be of excellent quality, is drier than fine hard Para, and only loses from 3 to 7 per cent. on washing. The process is said to be rapid, one hour being sufficient to coagulate

12 litres of latex, compared with about one and three-quarter hours taken by the usual process.

The use of sodium bisulphite for the production of pale-coloured plantation rubber is described by Beadle, Stevens, and Morgan (*India-Rubber Journ.* 1913, **46**, No. 5, p. 14). The process is cheap and effective; the results of tests on vulcanised samples of the rubber prepared show that no injurious effect is produced on the quality of the rubber.

The establishment of a department for testing plantation rubber is under the consideration of the Rubber Growers' Association (*India-Rubber Journ.* 1913, **46**, No. 24, p. 19). The object of such a department would be to submit samples of rubber to scientific and technical tests, which would replace the present inadequate method of valuation by brokers. An experimental factory in connection with the testing department would be advantageous, as technical work could be carried out for the information of manufacturers, and for the purpose of determining new uses for plantation rubber (cf. this BULLETIN, p. 76).

Manihot spp.—The results of experiments on the tapping of Ceara trees at the Malang experiment station, Java, are recorded by Dr. Arens in the *Mededeelingen* No. 6 *van het Proefstation Malang*, 1913. Eight groups of ten trees, $3\frac{1}{2}$ to 4 years old, and of an average circumference of about 26 in., were used for the experiments, the outer bark being removed, as is usual in tapping Ceara trees. Group 1 was tapped by the Bamber-Sandemann system; in this method a shallow, vertical groove is made in the cortex, and short, horizontal cuts are made along the groove by means of the four-bladed Bamber pricker and a mallet, the next tapping being made similarly about $\frac{2}{5}$ in. from the previous groove. High yields were obtained at the commencement, the first ten tappings giving an average of 3·06 grammes per tapping, but the process possesses the disadvantages that the number of incisions is so large that trees cannot be tapped for more than four months, and require nine months' rest, while a native can only tap twenty trees in an hour; there is also risk of damage to the tree.

Groups 2 and 3 were tapped by the Zuidergebergte method, in which a vertical cut is made through the cortex to the cambium, and running the length of the stem, the latex being collected in a cup at the base. Subsequent tappings are made similarly at distances of 1 in. In group 2 the incision was made with a knife, but the incisions opened widely and formed broad wounds; in group 3 a pricker was used, but the pieces of cortex between the pricker-cuts eventually split, forming similar wounds to those produced when a knife was used. The yield by this method was small, about 1·2 grammes per tapping for twenty-five tappings being obtained.

Groups 4, 5, 6 were tapped by methods usually employed for *Hevea* trees. In group 4 the half-herring-bone system, with three cuts 18 in. apart renewed daily, on one-third of the circumference, was used. This method gave a lower yield than the Bamber-Sandemann system, but the yield of rubber did not fall off so rapidly, while a native could tap 200 trees in a day. In group 5 the same system was used, but narrow strips of cortex were left between the daily cuts. This method gave a very small yield, while the bark consumption was four or five times as great as in group 4. In group 6 the herring-bone method was employed, using a pricker; this did not increase the yield.

Dr. Arens concludes that the half-herring-bone method is the best of those tried, but that a vertical channel is not needed. A thousand trees, three to five years old, were tapped daily for three months by this method, three cuts, 18 in. apart, being made on one-third the circumference; previous to tapping, strips of outer bark about 4 in. wide were removed. For the whole period of three months 4½ oz. of rubber per tree were obtained.

Experiments were also made to ascertain the influence of the number of tapping cuts and of the length of cut on the yield, and the yield at different heights.

With good tapping the bark renewal of Ceara trees is more rapid than that of *Hevea*; three years are said to be sufficient for Ceara trees. When tapped by the herring-bone system, the renewed cortex is stated to be as thick one year after tapping as the original cortex, and to give an abundant flow of latex.

A new method of tapping introduced by Migdalski in German East Africa is said to be giving satisfactory results (*Der Pflanzer*, 1913, **9**, 473). The method obviates the tedious removal by hand of the rubber from the cuts on the trees. A piece of strong, coarse cloth, 28 in. long and about 5 in. wide, which has been previously soaked in acetic acid or other coagulating solution, is applied to the tapping cuts and patted down by hand; it is then stripped off, and carries the rubber with it. The rubber can be removed easily from the cloth when about 10 oz. have been collected. The method possesses the advantages of requiring a smaller number of cuts, and less skill, while the amount obtainable by one man in a day was found to be 780 grammes compared with 280 grammes by the usual Lewa method; the rubber produced is cleaner.

Manihot dichotoma has failed to give satisfactory results at Peradeniya, Ceylon (*Trop. Agriculturist*, 1913, **41**, 278): 354 trees, stabbed four days running every fortnight in June and July, only yielded 5 lb. of rubber.

Ceara rubber produced on the Government farm at Kegalu, Mongalla Province, Sudan, sold in London at 4*s.* 4½*d.* per lb. with "fine hard" Para at 4*s.* 10¾*d.* (*Ann.*

Rept. Cent. Econ. Bd. Sudan for 1912, p. 45). The Ceara plantations at Sennar made good growth in spite of the poor rainfall. *Manihot dichotoma* and *M. piauhyensis* are also growing well here, and are free from fungoid diseases, such as have attacked and destroyed some 200 trees of *M. Glaziovii*. In the Government reserve, Sennar, 460 acres have been divided up into 20-acre plots, with roads 15 ft. wide; the 6 miles of road have been planted with Ceara rubber trees 9 ft. apart, and 25,000 trees have been planted in three of the blocks. The trees are in good condition; the total number of trees, including those planted in 1911, was 65,000.

Fibres

Sisal and Mauritius Hemps.—The cultivation of experimental plots of Sisal and Mauritius hemp plants at various altitudes in Nyasaland has shown that the higher localities are too cold, and that the most profitable results are obtained below 2,500 ft. In the *Ann. Rep. Dept. Agric., Nyasaland Protectorate, for the year ending March* 31, 1913, it is stated that there are now 856 acres devoted to Mauritius hemp, and 152 acres to Sisal hemp, and it is expected that the area will shortly be extended. A "New Corona" machine for preparing the fibre has been installed in the Blantyre District, and during the year under report about 60 tons of Mauritius hemp were extracted. The fibre was of good quality, and realised £29 5*s*. per ton in the United Kingdom. The plants were very small, and the yield of dry fibre amounted to only about 1¾ per cent. of the weight of the fresh leaves.

The cultivation of Mauritius hemp (*Furcræa gigantea*) in Natal has now attained a position of commercial importance, and appears to be a very promising industry. It is stated in the *Board of Trade Journal* (1914, **84**, 44) that about 15 tons of fibre are exported each month, and that this output might be considerably increased if superior machinery were introduced. About 1,000 acres are now devoted to the crop, and the average yield is about 1 ton of fibre per acre. The product has been realising very good prices on the London market, and compares favourably with that derived from other countries.

Paper-making Materials.—There are enormous areas in Northern and Central India covered with waste grasses which are at present of little or no economic value. An examination of some of the more important of these plants has been made by Mr. W. Raitt, of the Forest Research Institute, Dehra Dun, and his results are embodied in a "Report on the Investigation of Savannah Grasses as Material for the Production of Paper-pulp," which has been published recently as *Indian Forest Records* (vol. v., part III). It has been found that each of the following

grasses yields a pulp of first-class quality, and that they can be treated in admixture with one another without reducing the value of the product: *Saccharum spontaneum*, L.; *S. arundinaceum*, Retz; *S. Munja*, Roxb.; *S. Narenga*, Wall.; *Anthisteria gigantea*, Cav., sub-spp. *arundinacea*, Hack., and *villosa*, Hack.; *Arundo Donax*, L.; *Phragmites Karka*, Trin. These pulps all possess good strength, bleaching capacity, and felting power. The five following species are somewhat inferior to these in quality and strength of fibre, but may be mixed in moderate quantities with the eight species mentioned above without materially deteriorating the yield and quality of the pulp: *Saccharum fuscum*, Roxb.; *Andropogon intermedius*, Br.; *Vetiveria zizanoides*, Stapf; *Andropogon Nardus*, L. (forma *normalis*, Hook. f.); *Erianthus Ravennæ*, Beauv. The following are still more inferior, and are rather difficult to bleach, but may be used in admixture up to 10 per cent. without detriment to the product: *Imperata arundinacea*, Cyrill; *Eragrostis cynosuroides*, Beauv. Only three grasses were found to be unsuitable for mixing with those of the first class, viz. *Andropogon contortus*, L.; *Aristida cyanantha*, Steud.; and *Triraphis madagascariensis*, Hook. f. To obtain maximum yields of pulp, the grasses should be cut when in flower. *Saccharum arundinaceum* gives an average annual crop of about 14·8 tons of dry grass per acre, which is twice as great as that of any other species. Analyses of the grasses are given, particulars of the method of preparing the pulp are supplied, the length and diameter of the ultimate fibres are recorded, and costs of production of the pulp have been worked out.

Cotton

Reference has been made in this BULLETIN (1913, **11**, 143) to the "Durango" variety of cotton, which was introduced into the United States from the boll-weevil infested regions of Mexico. This variety gives a large yield of seed-cotton which furnishes 31 to 32 per cent. of lint on ginning. The fibre is of uniform character, and $1\frac{3}{16}$ to $1\frac{1}{4}$ in. long. In *Circulars* Nos. 111 and 121 (1913) of the *Bureau of Plant Industry, U.S. Dept. Agric.*, an account is given of the introduction and cultivation of "Durango" cotton in the Imperial Valley, Southern California, where excellent results have been obtained, and where 6,000 acres were planted with it in 1913. This cotton has met a demand for a long-stapled variety adapted to the local conditions, and promises to be of great benefit to the farmers of the Imperial Valley. The plant produces large bolls, and the cotton is no more troublesome to pick than that of short-stapled varieties.

During the year 1913, Mr. O. F. Cook, of the Bureau of Plant Industry, U.S.A., observed the occurrence in Arizona

of a weevil, resembling the Mexican cotton boll-weevil, in the bolls of a wild shrub known as *Thurberia thespesioides* (= *Gossypium Thurberi*), which is closely allied to the ordinary cotton plant, and is known by the Mexican natives as "wild cotton." This new insect, *Anthonomus grandis thurberiæ*, and its life-history are described in the *Journal of Agricultural Research* (1913, **1**, 89). It has been found that the Arizona weevil can feed and multiply on the ordinary cotton plant, and that the Texas boll-weevil (*Anthonomus grandis*, Boh.) will readily attack Thurberia. The importance of the discovery lies in the fact that Thurberia plants have been observed in the vicinity of the Santa Cruz Valley, and within ten miles of cotton plantations which were only established in 1913, and which will probably be greatly extended during the present year. The ordinary Texas weevil has not yet successfully invaded the drier cotton regions of Western and North-Western Texas, but it is believed that the Thurberia weevil could withstand the rigorous climate of these areas, and might inflict great damage on the cotton crop. It is therefore necessary that every effort should be made to prevent the introduction of the new pest into Texas.

Considerable damage has been effected during recent years in certain parts of the United States by the minute reddish mite (*Tetranychus bimaculatus*), commonly known as the "red spider," which infests the under surfaces of the leaves of the cotton plant. An account of the life-history of this pest and of the methods of controlling its ravages has been given in *Circular* No. 172 (1913), *Bureau of Entomology, U.S. Dept. Agric.* The attack is manifested by the appearance of blood-red spots on the upper surfaces of the leaves; the leaves gradually fall off, and eventually the plant dies.

Grenada.—The cultivation of cotton was an important industry in Grenada in the eighteenth century, but was subsequently abandoned. There is a large area, probably not less than 2,600 acres, of land, at present uncultivated, which appears well adapted for the crop. During recent years several attempts have been made to revive cotton-growing in Grenada, and reference to these efforts is made in an article in the *West Indian Bulletin* (1913, **13**, 358). All these attempts to re-establish the industry have failed owing to the prevalence of a bacterial disease which attacks the bolls of both Marie Galante and Sea Island varieties. This disease does not seem capable of control by direct methods, but it is considered that, with a view to evading it, observations should be made as to the best time for planting, trials should be conducted with several different varieties of cotton, and hybridisation, selection, and manurial experiments should be undertaken. A series of ex-

periments has been planned which, if systematically carried out, would probably furnish valuable information.

Nyasaland.—Cotton still continues to be the most important crop grown in Nyasaland. In the *Ann. Rep. Dept. Agric., Nyasaland Protectorate, for the year ending March* 31, 1913, it is stated that there are 25,697 acres under cultivation, and that during 1912–13 the exports amounted to 8,093 bales of 400 lb., as compared with 3,392 bales in the previous year. It is considered that, owing to the insufficiency of native labour and the primitive system of cultivation now in vogue, the acreage under European management is not likely to undergo much further increase at present; but it is anticipated that when the Protectorate has been connected by railway with the coast and Lake Nyasa the number of settlers will increase, and the estates will become better equipped. The native cotton industry is gradually increasing, but the production by the natives during the year under report amounted to only 1,126 bales of 400 lb. as compared with 1,454 bales in 1911–12, this diminution being due to severe drought which prevailed in the Lower Shire and Ruo Districts, where most of the native cotton is produced. An attempt has been made in the Mlanje and Upper Shire Districts to encourage the native growers to grade their cotton, and Government markets have been established in which the cotton is inspected and weighed by officers of the Government before being offered for sale. This experiment has been so successful that it has been decided to apply the same system to all the cotton-growing districts. In order to provide the necessary funds for establishing and maintaining the markets, purchasers are required to obtain a licence (costing 10*s*.), and to pay market fees at the rate of 3*d*. per cwt. of seed-cotton purchased. By arrangement with the British Cotton Growing Association a small premium has been guaranteed to natives who grade their cotton. The advantage of grading the product is that better prices are secured for the ginned cotton, and that it obviates the exportation of large quantities of inferior or unsaleable cotton, and consequent loss to the exporter. The Department of Agriculture is paying attention to the quality of the seed supplied to the natives for sowing, and the production of carefully selected seed on the Government farms is being continued.

Erythræa.—The cultivation of cotton was commenced in the Italian Colony of Erythræa in 1904. During the first two seasons attempts were made to grow Egyptian varieties, but subsequently it was found that American kinds gave much better results. A short account of the industry was contributed by Mr. A. Moretti to the "Ninth International Congress of Delegated Representatives of Master Cotton

Spinners' and Manufacturers' Associations" in 1913, and has been published in the *Official Report* of the Congress (p. 357). A variety of American cotton, known as "Carcabat" from the native name of the place where it first appeared, has a length of $1\frac{1}{8}$ to $1\frac{3}{8}$ in., and is fine, silky, and fairly strong. Consignments of this cotton have been sold in Liverpool at $8\frac{1}{2}$*d.* per lb., with "middling" American at 6·62*d.* per lb. The industry has encountered certain difficulties on account of the war with Turkey, but it is hoped that ere long these will have disappeared. Attention is being directed to the possibility of irrigation and the development of railways, and it is anticipated that in virtue of the favourable climatic conditions and the intelligence of the natives, it may be possible to produce large quantities of cotton in Erythræa.

Tripoli.—On p. 358 of the Report just mentioned reference is made to experiments which are being undertaken in Tripoli with certain American Upland cottons, including "Mebane" and "King" varieties.

Asia Minor.—During the Congress referred to above a report was made on the progress of cotton growing in the Levant (*Official Report*, pp. 324, 325), in which it was stated that in the seasons 1911–12 and 1912–13 the crop increased considerably in quantity, and also showed a decided improvement in quality. This advance is due to the increasing care bestowed by the peasants on the cultivation of the crop, and to the use of improved ginning machinery. The industry has suffered considerably owing to the labourers being recruited as soldiers, and on account of other difficulties occasioned by the Turco-Italian war. Further obstacles to the development of cotton-growing were the subsequent Balkan war, political and economic troubles, and the occurrence of a plague of locusts in the Smyrna hinterland.

Tobacco

Tobacco Wilt.—The results of the investigation at Pusa into the cause of the tobacco wilt disease, which recurs annually in the Rangpur district of Bengal, are recorded in *Memoirs Dept. Agric. India, Bacteriological Series* (1913, **1**, No. 2). The disease is due to a bacterium similar to *B. solanacearum*, Smith, which causes the Granville tobacco wilt of the United States. The infection enters the plant at a point of mechanical injury, or through the intervention of such organisms as nematodes, which bore into the root or collar of the plant. Transplanting and the removal of lower leaves provide occasion for the former class of wounds. The author rejects the generally accepted theory that the wilting effect is due to the plugging of the vessels

by masses of bacteria, and consequent interference with the water current in the plant, and considers it to be due to the action of secreted toxins on the protoplasm. Hot-weather ploughing is advocated in order to aid the destruction of the bacteria, which do not survive a temperature of 50° C. This treatment also conserves soil moisture and favours root development, producing stronger and more disease-resistant plants. It is stated that an alkaline reaction in the soil encourages the growth of *B. solanacearum* by enabling it to overcome the unfavourable acidity of plant juices; on this account, manures producing an alkaline reaction in the soil should be avoided.

Drugs

Belladonna.—The *Journ. Agric. Research* (1913, **1**, 129) contains an article by A. F. Sievers on "The Individual Variation in the Alkaloidal Content of Belladonna Plants." The author describes a large number of experiments which were carried out as a preliminary step towards the application of methods of selective breeding to the belladonna plant, with a view to increasing the amount of alkaloid present in the leaves. The object of the experiments was to correlate, if possible, the alkaloidal content of a plant with (1) its stage of growth, (2) its size and appearance, and (3) soil and climate. Experimental plots were grown at Arlington, Va., Bell, Ind., and Madison, Wis. Plants were selected at random from the plots, and leaves from each were picked at different times during the growing season, in order to determine the time of year at which the leaves contained the greatest percentage of alkaloids. The physical appearance of each plant was also noted, the distinguishing features in this case being the height of the plant and the number of stems. Immediately after picking, the leaves from each individual plant were air-dried separately and the amount of alkaloid present determined. Further analyses were performed in order to investigate the variation in the alkaloidal content of the leaves of individual plants. The general results arrived at indicate that the best time for picking the leaves is from the time of flowering until the early berries begin to ripen; for, although the leaves are richer in alkaloids later in the season, they are then too few and small for harvesting. No indication was found of any relation between the physical appearance of a plant and the alkaloidal content of its leaves. It was found, however, that a considerable number of plants with leaves rich or poor in alkaloids in one season bore correspondingly rich or poor leaves in the following season. Furthermore, the plants frequently manifested the same characteristics at the various stages of growth during one season as during the previous season.

Buchu.—The culture of the buchu plant is the subject of an article by G. R. von Willeigh in the *Agric. Journ. Union of South Africa* (1913, **6**, 80). The author points out that, although the price of the exported leaf rose about 500 per cent. during the years 1908–12, the exports from South Africa diminished from 243,742 lb. to 223,021 lb. in the same period. This he ascribes to careless methods of culture and collection, and also to the destruction of seedlings and young plants by veld fires. It is stated that the adulteration of buchu leaves has also caused a diminution in the demand for this drug. The article gives a description of experiments, carried out by the author, in the cultivation of mountain buchu (*Barosma betulina*) and the kloof or fountain buchu (*B. serratifolia*). From these experiments the author concludes that the latter variety possesses greater vitality and is easier to cultivate than the former. The varieties and uses of the drug are described, and directions for its cultivation are given.

FORESTRY AND FOREST PRODUCTS

According to Mr. H. H. Corbin (*Journ. Dept. Agric. South Australia*, 1913, **17**, 152), the value of timber imported oversea by South Australia in 1911 was £386,707. The timber sawn amounted to over 45 millions super ft., valued at £520,315. Timber to the value of £12,356 was used as pit props in mines during 1912, an increase of about £1,000 on the previous year's figures. Timber used for sleepers in the State is rapidly decreasing in quantity, and numbers of these are now imported. The number of jarrah wood paving blocks used in Adelaide up to December 1912 was 1,595,800, costing £16,755.

As regards the wattle bark industry, it is pointed out that in certain years Australia does not produce bark in sufficient quantities for its own consumption, and imports a considerable quantity from Natal. In 1910–11 the production of wattle bark in South Australia amounted to 6,598 tons, and in 1910 bark to the value of £15,208 was exported oversea. The price of wattle bark in 1912 was £7 per ton, and the average annual production 7,000 tons. The industry is much handicapped by the scarcity and high cost of labour. In Natal, where the climate is good and labour is cheap, the industry is developing steadily, and there is no doubt that South Africa is gaining what the Commonwealth is losing in this industry.

According to the *Annual Report for* 1912 *of the Director of Queensland Forests*, the area in that State temporarily reserved at the end of the year was 3,211,855 acres, an increase of 343,518 acres on the figures for the previous year. Despite the depression reported to exist in the sawmilling industry in the latter half of 1912, the figures for

the year showed no decline on the previous year's figures except in the cases of milling hardwood and cypress pine. The number of sawmills in operation during the period covered by the *Report* was 258; the amounts and values of the timbers cut were as follows: softwoods, 107,780,777 super ft., value £829,617; cedar, 885,791 super ft., value £19,850; hardwoods, 55,160,910 super ft., value £478,015. All these figures show a substantial increase on those of the previous year. The timber revenue for the year amounted to £63,446, as compared with £53,840 in 1911.

Casuarina.—Reference has previously been made in this BULLETIN (1913, **11**, 357) to the plantations of *Casuarina equisetifolia*, on the sea-coast of the Bombay Presidency, which have been formed for the production of fuel. On this subject a correspondent contributes to the *Indian Forester* (1913, **39**, 380) an account of the methods employed in the Kolaba district, which have given good results. In order to avoid the labour involved in watering the seedlings during their first years in the plantation, they are kept in specially constructed nursery beds for from 12 to 18 months prior to planting out, and are then found to succeed without artificial watering. The nursery beds employed consist of a wooden platform, 4½ ft. square, made of casuarina branch-wood latticed together and supported on four wooden posts, 9 in. thick, that stand 2½ ft. above ground. A layer of soil 10 in. deep is formed on the platform, and in this the seed is sown. A bed of the dimensions stated will accommodate from 500 to 700 seedlings, which, at the end of from 12 to 18 months, have an average height of 5 ft. By loosening the lattice-work of the platform the seedlings can readily be removed for planting without injury to the roots. The planting out is done about a week after the break of the monsoon, in holes 18 in. deep, formed at the time of planting. Prior to the year 1911 a spacing of 6 ft. was adopted, but more recently the spacing has been 12 ft. apart, in squares or triangles. Stakes are necessary to support the plants for the first two years after planting out. Another method which has been employed with success consists in transferring seedlings from the nursery bed, when 6 months old, to locally made earthen pots measuring 9 in. in diameter and 6 in. in depth, in which they remain until 18 months old, when they are planted out as above described. The pots can be used repeatedly. The roots are not damaged by this method, and the subsequent growth of seedlings is very rapid.

Eucalyptus.—A note on the plantations of blue gum (*Eucalyptus globulus*) in the Nilgiris, prepared by Mr. R. S. Troup, of the Forest Research Institute, Dehra Dun, forms the subject of the *Indian Forest Records* (1913, **5**, pt. ii.). As early as 1843 experimental plantations were started with

a view to replacing the natural forests which had been destroyed to supply the demand for fuel created as a result of the establishment of European settlements. It was not, however, until 1856 that plantations of blue gum on an extensive scale were formed; this species having been found the most valuable as a fuel tree. Plantations either pure or mixed with wattles (*Acacia dealbata* and *A. melanoxylon*) are now to be met with everywhere, belonging either to the Government or to private owners, and as a result fuel is considerably cheaper in the Nilgiris than in any of the Himalayan Hill stations which draw their supplies from natural forests.

The eucalyptus plantations are situated chiefly in the neighbourhood of Ootacamund, Coonoor, and Wellington, at elevations varying from 5,500 to 8,400 ft.; the best being at from 7,200 to 8,000 ft. The climate of this region is fairly cool, equable and moist, with a well-distributed rainfall of about 50 to 80 in.; although frosts occur, the winters are mild on the whole, and snow is unknown. The soil, a red clay overlying gneissose rock, is rich and deep in some parts, shallow and poorer in others.

The sylvicultural management of blue gum consists in raising seedlings in a nursery in beds of well-dug soil, free from gravel, and raised slightly, so as to afford good drainage. When about 3 in. high the seedlings are transplanted into other beds and spaced 3 in. apart, and when 6 in. in height they are transferred singly to bamboo baskets, 12 in. in depth by 9 in. in circumference, filled with light, rich soil. As soon as the baskets are filled with roots the seedlings are planted out, with their baskets, in pits measuring 1½ ft. cube, which are opened about 3 months before the time of planting. In most plantations the spacing is 6 ft. by 6 ft., in others a spacing of 9 ft. by 9 ft. has been adopted. Taking into consideration the extra amount of labour involved and the larger number of seedlings required in planting out 6 ft. apart, there is overwhelming evidence in favour of the wider spacing. After being planted out the seedlings require no further attention beyond a slight covering of bracken during frosty weather. The blue gum coppices well after it has attained a girth of 5 ft., and the young coppice shoots grow rapidly; in the case of a coppice crop in the Coonoor Peak plantation a height of 45 ft. was attained in 4 years. The coppice coupes are worked on a 10-year rotation.

The blue gum produces fertile seed at an early age, and in some of the plantations natural seedlings have been observed. It is not possible to give the actual figures of the cost of planting and maintaining these plantations, but from an estimate included in the note, it appears that the initial cost of planting is approximately Rs. 65 per acre for 6 ft. by 6 ft., or Rs. 46 for a spacing of 9 ft. by 9 ft.; the

annual recurring expenditure is estimated at R. 1 per acre. The net money value of the produce of one acre of blue-gum coppice at 5 years is estimated at Rs. 70, at 10 years Rs. 199, at 15 years Rs. 331, and at 20 years Rs. 461.

The possibility of utilising species of eucalyptus as fuel-producers in connection with the lime industry in St. Lucia, West Indies, is suggested in the *Report on the Agricultural Department, St. Lucia*, 1912–13. Several species of eucalyptus, including *E. paniculata* and *E. robusta*, are already thriving well in the island, and in the Botanic Station two trees that were coppiced in 1901 have made shoots that at the present time measure respectively 104 and 81 ft. in height and 6 ft. 7 in. and 5 ft. 3 in. in girth at the base, an average rate of growth of 7·7 ft. per year. These satisfactory results justify the suggestion that trial plantings of eucalyptus should be made wherever fuel is required or wind-breaks are necessary.

In the island of Dominica, West Indies, a large collection of species of eucalyptus has been brought together at the Botanic Gardens, and experiments have been started with a view to ascertaining which species are the most suitable for planting in the island as fuel-producers. As a result of these experiments, the species recommended in the *Report of the Agricultural Department, Dominica*, 1912–13, for trial on estates, are *Eucalyptus tereticornis*, *E. citriodora*, *E. rudis*, *E. rostrata*, *E. cornuta*, *E. patentinervis*, and *E. oreades*. Also recommended, but of less vigorous growth than the foregoing species, are *Eucalyptus alba*, *E. Maideni*, *E. paniculata*, *E. saligna*, and *E. tessalaris*.

Sál (*Shorea robusta*).—An account of the economic value of *Shorea robusta*, prepared by Mr. R. S. Troup, F.L.S., Economist at the Forest Research Institute, Dehra Dun, forms the subject of the *Indian Forest Memoirs, Economy Series* (1913, **2**, pt. ii.). The Sál tree is an important constituent of Indian forests, and yields one of the strongest and most durable of Indian timbers. Of the total annua outturn of India and Nepal, estimated from the latest figures available at 8,120,551 cubic ft., some 2,549,766 cubic ft. were converted into railway sleepers, and the remainder employed in constructional work. Details are given as to the structure, methods of seasoning, strength, fissibility, and hardness of Sál timber, and of its durability under different conditions. According to Dr. Leather, the evaporative power (lb. of water at 212° F. evaporated by 1 lb. of wood) is stated to be 8·45, whilst the results obtained by Mr. Puran Singh, the Forest Chemist, give 9·188 for completely dried material. Amongst minor economic products of the Sál tree to which reference is made are the resin, obtained by tapping, and an edible fat derived from the seeds and employed locally to adulterate "ghi."

Sandalwood.—The experimental cultivation of sandalwood (*Santalum album*) was continued in the Northern Circle, Madras, according to the *Annual Administration Rep. of the Forest Dept. of the Madras Presidency*, 1911–12, pp. 12, 29, but owing to drought there was great mortality amongst the seedlings immediately after germination, and also amongst the larger trees owing to the death of their hosts. In the Central Circle the results of the experimental planting of sandal, conducted many years ago, are now becoming apparent. In several of the forest reserves, sandal trees are now spreading naturally into surrounding areas from centres which were artificially planted in the first instance. This spread of sandal into fresh areas is important, and it has increased interest from the fact that immature trees extracted from the Kodur plantation, at a low level, have given a fair proportion of scented wood, which, on analysis, has been found to be in no way inferior in oil value to that grown on the hills.

Teak.—Particulars of experiments to ascertain the best means for inducing the natural regeneration of teak (*Tectona grandis*) are given in the *Rep. on the Forest Administration in Burma*, 1911–12, p. 30. The experiments were conducted in the Mohnyin and Bilumyo Reserves of the Katha Division. The area selected for the experiments were previously covered with teak, and at the end of the forest year 1910–11 there was a plentiful supply of seedlings due to natural reproduction. Portions of these areas were kept weeded, in accordance with the rules laid down in the working-plan, whilst other portions were left unweeded, and simply burnt over each year. The latter method was found to result in failures, whilst on the weeded portions the results are said to be very promising. It follows from these results that although natural germination may be successful, the subsequent establishment of teak by natural regeneration requires the aid of continual weeding and attention for some years, until the teak has outgrown all other vegetation. In the weeded areas it was observed that teak seedlings with the slightest over-head cover were very backward and covered with mud. This is attributed to the drip from the over-head leaves rather than to the shade. It is suggested in this connection that in future it would be advisable to sacrifice small teak trees in the interests of a uniform crop where it is found that seedlings have sprung up under their crowns.

The old regeneration areas in the Mohnyin Reserve were successfully burnt over during the hot season, and after burning all forked and crooked stems were cut out and coppiced. The result of this operation has been that healthy coppice shoots have been produced, and this tends to prove that satisfactory growths can be induced by cutting back after establishment.

Timber

Three new timber-yielding species occurring in the Annam mountains are described in *L'Agronomie Coloniale*, (1913, **1**, 38, 76), by Ph. Eberhardt and M. Dubard. The first of these, *Wrightia annamensis*, is a small tree very abundant in Annam, as well as in Tonkin. The wood is used for making shoes, and also for the seals of the secondary mandarins, those of the higher mandarins being engraved on ivory. It resembles boxwood in structure. The second species, *Symplocos multiflora*, affords a timber frequently used for building purposes. The other species described is *S. Dung*, the wood of which is used for making ploughshares and harrows.

Cedar Woods.—A list of the various timbers to which the name "cedar" has been applied is given in *Kew Bulletin*, (1913, No. 6). The name was, in all probability, first used to designate the Cedar of Lebanon (*Cedrus Lebani*, Loud.), although the fragrant wood of this species is of little value except as fuel. Subsequently the name was applied to other trees that resembled the Cedar of Lebanon or to woods that possessed a similar fragrance. The "cedars" enumerated in the list number some fifty-seven species belonging to fifteen natural orders. Of these the most important is the true pencil-cedar (*Juniperus virginiana*, L.), which has a wide distribution in North America, and furnishes a wood that has no equal for the manufacture of pencils. Many of the other species mentioned furnish useful cabinet woods, but only two are referred to as substitutes for *J. virginiana* for the manufacture of pencils—namely, *J. barbadensis*, L., the Barbados or Southern red cedar, native to Southern United States and the West Indies, formerly extensively used for pencil making, but now becoming scarce, and *J. procera*, Hochst., the East African cedar, which promises to be of value as a pencil-cedar substitute when it becomes better known. The latter is already being exported to Europe from German East Africa, and specimens of the timber from British East Africa were favourably reported on by the Imperial Institute some years ago (this BULLETIN, 1906, **4**, 15).

Pine Timber in Great Britain.—The first two *Bulletins* issued by the University of Cambridge School of Forestry form part of a series by Messrs. E. Russell Burdon and A. P. Long, which it is intended to publish at intervals, giving the results of their work regarding the production and utilisation of Scots pine timber in Great Britain. The principal object of this research is to determine as closely as possible the economic possibilities of the tree, and to estimate the extent to which the timber, when grown under proper sylvicultural management, is capable of taking the place of foreign timber of the same class. The first *Bulletin*

gives measurements and calculations taken in woods of Scots pine at Woburn, Bedfordshire, on selected sample plots. The second *Bulletin* deals in a similar manner with trees at King's Lynn, Norfolk.

Tanning Materials

Mangrove.—A concession has recently been granted for the exploitation of the mangrove forests in New Caledonia, where the commonest species is a red mangrove, *Bruguiera Rumphii* (*Journ. d'Agric. Trop.*, 1913, **13**, 336).

Oak Bark.—Enquiries are being pursued by the Forest Research Institute in the United Provinces, India, with regard to the possibility of utilising Indian oak bark as a tanning material, either in the raw state or in the form of extract. The analyses given in the *Indian Forester* (1913, **39**, 420) show that the Indian oak barks compare very favourably with those of European species of oak as regards their tannin content. The highest yields recorded by the Forest Chemist are as follows: *Quercus pachyphylla*, 22·44 per cent. of tannin, expressed on the dry material; *Q. lineata*, 15·84 per cent.; *Q. incana*, 11·52 to 13·28 per cent.; and *Q. spicata*, 11·90 per cent. It is not considered likely that this material in the raw state will find a remunerative market in India, as it would have to compete with "babul" (*Acacia arabica*) bark and myrobalans, both of which can be supplied cheaply and in large quantities, and at the same time are richer in tannin. It is stated that if tanning extract can be made from Indian oak bark at a cost not exceeding £6 per ton, it can be put on the European markets at a price which will enable it to compete with the extract manufactured in Europe. At present, however, it does not appear that extract can be manufactured so cheaply in India, owing to the high cost of the collection and transport of the bark to a central factory; but information is being collected with a view to ascertaining if this cost can be lowered.

Quebracho.—An account of the quebracho industry in Paraguay is given in the *Leather Trades' Review* (1913, **46**, 748). The industry was commenced in Paraguay in 1889, and at the present time there are six factories with a total output in 1912 of 17,000 tons of tanning extract. Practically all the extract is exported, 40 per cent. going to North America and the rest to Europe. The demand for this material is stated to be increasing in consequence of the decline in the use of oak bark.

The raw material used in Paraguay for the manufacture of quebracho extract is the trunks and branches of the red quebracho tree (*Aspidosperma Quebracho-colorado*), and also of the "Urundey" or "iron" tree.

The recent revolution in Paraguay has considerably

interfered with this industry, but a slight impetus has been given by the alteration of the custom duties. The chief difficulty encountered appears to be the lack of sufficient labour.

For an account of the different kinds of quebracho occurring in South America see this BULLETIN (1912, **10**, 683).

Wattle.—The wattle bagworm (*Chalioides junodi*, Heylaerts) proved so very injurious to the wattle plantations of the New Hanover district of Natal in the summers of 1911 and 1912 that a study of this insect is being undertaken by the Division of Entomology with a view to devising methods for its control (*Agric. Journ. South Africa*, 1913, **5**, 838; 1913, **6**, 19, 198). The larva of this moth feeds on the leaves, and the defoliation leads to "bark-binding" and a reduction in the quantity of bark formed, amounting in very bad cases to as much as 75 per cent., but usually varying from 10 to 20 per cent. The damage, however, never appears to be so great that the bark is not worth harvesting. An account is given of the life-history of the pest and the influence of climatic conditions on it: the possibility of reducing its depredations is discussed.

Miscellaneous.—An account is given in *Der Tropenpflanzer* (1913, **17**, 463, 557, 619, 676) of the chief tanning materials available in, or that might be produced in the German African colonies, with the object of supplying the German markets with raw material for their leather industry. At present, Germany relies largely on foreign countries for these supplies. Among the materials described are mangrove, wattle and mallet barks, divi-divi pods, and gambier, of which the first two are the most important. Supplies of mangrove bark from German East Africa have already been put on the German markets. A number of other tanning materials are also found in these German colonies, but their low percentage of tannin prevents them from being used other than locally by the natives.

Gums

Sudan Gum.—The quantity of gum exported from the Anglo-Egyptian Sudan in 1912 constituted a record, being 19,615 tons, valued at £618,600, as compared with 14,357 tons, valued at £446,512, in 1911. This product is still the most valuable Sudan export, but it is thought that it will probably be outstripped in the course of the next few years by cotton and live stock (*Ann. Rep. Cent. Econ. Bd., Sudan*, 1912, p. 18). The trade in 1912 suffered from over-production owing to the fact that the high price at which gum had been selling for years past, combined with the comparative failure of food crops in Kordofan and other parts

of the country, induced the natives to collect gum in larger quantities. The output was also influenced by the new railway between El Obeid and Khartoum, which enabled the gum to be disposed of much more rapidly than in former years. This excessive supply caused the price in Europe to fall from 35*s.* to 40*s.* per cwt., in the beginning of the year, to 33*s.* per cwt. towards the end; at this figure the price has since remained.

To counteract the ill effects of this surplus production, the Government postponed the levying of the higher royalty rates on the gum from November 1st to December 1st. The royalty on gum was increased to help to defray the cost of the work, which is being undertaken for the conservation of the forests which have been exploited so rapidly in the last few years, and in some cases even denuded.

Results, other than those already mentioned, from the completion of the railway to El Obeid, were that the supplies of gum continued to arrive at Khartoum from the interior, as late as August, whereas in former years they ceased at the commencement of the rains in May; also large quantities of gum were consigned direct from El Obeid to Port Sudan for shipment, without going through Khartoum, whereby a saving in freight charges was effected.

A feature of the gum trade in 1912 was that the price of "hashab" gum from Gezira approximated that of "hashab" gum from Kordofan, instead of being considerably lower as in other years.

ECONOMIC MINERALS

Coal.—The Geological Survey of India has issued a new edition of V. Ball's "Coalfields of India" (*Mem. Geol. Surv. India*, vol. xli. 1913). The new edition has been revised and largely re-written by R. R. Simpson, Inspector of Mines. Since the issue of Dr. Ball's memoir in 1881, the coal-mining industry has made great progress, the extent of which has been noted in the reports on the mineral production made annually by the Director of the Geological Survey of India, and in Sir Thomas Holland's *Sketch of the Mineral Resources of India*, published in 1908. The following table gives some indication of the extent of this coal-mining development in India since 1881:

Year.	Production.	Imports.	Exports.
	Tons.	*Tons.*	*Tons.*
1881	997,730	805,924	1
1891	2,328,577	775,933	4,061
1901	6,635,727	237,435	587,871
1911	12,715,534	306,010	860,788
1912	14,706,339	552,249	897,194

Corresponding to this development in coal mining there have been great extensions in the railway system and increases in manufactures and foreign trade.

Of the imported coal, 77 per cent. is supplied by Great Britain, the rest being contributed in roughly equal amounts by Australia and Japan. In recent years attempts have been made to secure a market in India for Natal coal, but with no great success.

Wood fuel is still used on certain sections of the Indian railway system distant from sources of coal supply; the amount used, however, has diminished considerably in recent years, having fallen from nearly 400,000 tons in 1904 to 127,725 tons in 1910.

The coal deposits of India are of various geological ages, and all younger than the Carboniferous coal deposits of the United Kingdom. The oldest and by far the most important of the Indian deposits are those of Gondwana age (Permo-Triassic), which were formed about the same time as the Karroo deposits of South Africa. Coals of Jurassic, Cretaceous, and Tertiary ages also occur in India, and the Tertiary deposits are worked to some extent (see p. 123).

The memoir deals with the geological occurrence of coal in India, and gives a detailed account of the deposits. It includes a chapter on production, trade, and labour, and an exhaustive bibliography.

Copper Ore.—The New South Wales Department of Mines has issued a report by E. C. Andrews on the Cobar copper ore deposits (*Geological Survey, Mineral Resources*, No. 17, 1913). Cobar lies on a plain of denudation, the loftiest elevation in which is at a locality twenty miles S.E. of Cobar, and reaches 500 ft. Elsewhere the heights do not exceed 200 ft., and the surface is covered to such an extent by a sheet of surface detritus that no natural sections are to be seen. The oldest fossiliferous sediments in the area are those of the Cobar series, including conglomerates, limestones, quartzites, sandstones, cherts, and shales of Silurian age. To the west of the township of Cobar there occurs an enormous thickness of sandstones and shales of Devonian age. No unconformity has been found between the Silurian and Devonian beds, but the eastern Silurian members appear to have been thrust over and against the western rocks, and this thrusting is supposed to have taken place during the orogenic movement that closed the Devonian period in this area. The only igneous rocks exposed in the whole of the Cobar district are two small pipe-like intrusions of orthoclase porphyry that lie thirteen and fourteen miles respectively to the S.S.E. of Cobar.

The Cobar district contains many ore deposits, the chief of which are those of copper and gold. These copper

deposits are the most important in New South Wales, and equal, or even exceed in importance the famous Mount Lyell deposits of Tasmania and the Mount Morgan deposits of Queensland. The Great Cobar copper-ore bodies themselves consist of three large lenses of chalcopyrite in a pyrrhotite and magnetite matrix, with considerable admixtures of slate and quartz.

The general strike of the Cobar lodes is about north 15° to 20° west, and they occur as siliceous or ferruginous gossans arranged along parallel lines of weakness in the Palæozoic rocks. In the eastern division of the area the ores are siliceous, whereas in the western division they are basic. It is noted that the basic western masses lie wholly in slates and claystones, whilst the siliceous eastern bodies occur at the contact of slates and sandstones.

The lodes may be divided into two types, namely, those characterised by the development of chalcopyrite and pyrrhotite, and those characterised by the presence of iron pyrites, galena, and zinc-blende. The pyrrhotite veins have no definite walls, but appear to be cemented into the country rock, whilst the pyritic lodes have walls much more clearly defined, and are generally younger than the bodies containing pyrrhotite.

The most important vein system is that which passes through the properties of the Great Cobar and the Great Cobar North. The main outcrop consisted of three small lenses of gossan, the central one showing blue and green carbonate stains, the other outcrops being barren. Rich carbonates and oxides were found below the surface, and the lenses were found to be connected with others by siliceous but unproductive belts of ore. Mining operations showed that these small outcrops were only the upper portions of larger and more important lenses of ore than had been suspected at the surface. Near the ground-water level, the rich oxidised zone passed into large masses of chalcocite and chalcopyrite, associated also with red oxide. At a depth of 400 ft. the richest class of chalcopyritic deposit had disappeared, and a much leaner class of chalcopyrite gradually took its place.

The evidence on the whole is regarded as indicating that, during the period of active earth movement that affected this area, the strata were dislocated to a great depth, affording access to the mineralising vapours and waters given off from the heated rocks below. In the coarse-grained rocks silicification was pronounced, whilst in the fine-grained rocks basic replacements were effected. In the Cobar Gold lode the silica percentage is about 80, that of the copper about 1·3, and that of the iron 8. In the Great Cobar lode the percentage of silica is about 17, sulphur about 15, iron about 41, copper 2·6, and alumina about 7.

The movement accompanying the formation of the deposits appears to have taken place in two stages. In the first stage pyrrhotite, magnetite, chalcopyrite, and an iron silicate, were the characteristic products. The later movements appear to have been associated with the deposition of a completely different set of sulphides, namely pyrite, galena, and zinc blende; pyrrhotite and magnetite are absent from these later deposits.

The climate in recent geological times has become semi-arid. The water-level lies at a considerable depth below the present surface. Descending waters have oxidised the sulphides, and re-deposited the matter in solution partly as oxides and carbonates above water-level, and partly as sulphides at and near the water-level.

The Cobar mining field was discovered in 1869, and mining began in 1870.

According to the *Annual Report of the Department of Mines, New South Wales*, for 1912, the Cobar District ranks next to Broken Hill as a centre of metalliferous mining in New South Wales. The metal output for 1912 is given as follows: Gold 66,801 oz. fine, value £283,751; silver 275,861 oz., value £28,784; copper 6,848 tons, value £410,155; lead 1,420 tons, value £23,393; total value £746,083.

Petroleum.—In *Memoir* No. 29E, 1913, *Department of Mines, Geological Survey, Canada*, W. Malcolm deals at some length with the oil and gas prospects of the North West Provinces of Canada, and gives a bibliography of the subject. The plains of western Canada are underlain by a mass of nearly horizontal sediments resting on a pre-Cambrian base. In the eastern part of the plains a great unconformity exists between the Palæozoic rocks, which consist of limestones, dolomites, and shales, and the Cretaceous system, which consists of shales and sandstones; and the Dakota sandstones of Cretaceous age are found resting directly on Devonian limestones. In western Alberta, and in some parts of south Saskatchewan, the Cretaceous sediments are overlain by Tertiary deposits, and overlying all is a mantle of unconsolidated Pleistocene and Recent deposits. In the west, the gap between the Devonian and Cretaceous is filled up by Carboniferous, Triassic, and Jurassic deposits.

Prospecting for oil has been carried on in two different areas in the Pincher Creek district, south-western Alberta, but with no great measure of success. In northern Alberta the Dakota sandstone shows impregnations of a bituminous substance believed to be a petroleum product, and it is thought that liquid petroleum exists in this porous rock at some distance from the outcrop. To test this, wells were drilled during the nineties by the Dominion Government at Victoria on the Saskatchewan, at Athabaska Landing, and

at the mouth of the Pelican river. In the first two wells the Dakota sandstone was not reached, whilst in the last it was reached at a depth of 750 ft. About 87 ft. of the sandstone was penetrated and found to contain maltha or heavy, tarry petroleum.

Prospecting for gas has been more successful. The boring at the mouth of the Pelican river proved the presence of a great reservoir of gas in the Dakota sandstones, and heavy flows were struck at 820 and 837 ft. In southern Alberta, also, gas is found in paying quantities. A good field exists at Medicine Hat, and flows have been obtained at several different points west of that city. At Bow Island, 8 wells sunk up to the date of February 21, 1912, showed flows varying between 1,250,000 to 29,000,000 cubic ft. per day. The pressure in these wells is 800 lb. per square inch. The wells have a depth of 1,890 to 1,930 ft., and gas is struck at three or four levels in the sandstone of the last 40 ft., and this is believed to be the Dakota sandstone.

Thus, whilst the presence of oil in commercial quantities remains to be proved, boring operations have demonstrated beyond doubt the existence of large reservoirs of natural gas, and it seems probable that further exploratory work throughout the wide area underlain by the Cretaceous rocks should lead to the discovery of other reservoirs. It is considered probable that the Devonian limestone is the source of the gas and petroleum products of northern Alberta, and that the porous Dakota sandstone forms the reservoir into which they have risen and in which they have been retained by the overlying shales. As the Devonian limestone and Dakota sandstone are of wide distribution, and probably underlie the western part of Manitoba and a great part of Saskatchewan and Alberta, the prospects for the discovery of other gasfields seem favourable. On account of the great thickness of sediments overlying these formations, however, the driller must be prepared to go to a considerable depth.

In a profusely illustrated memoir on the oilfields of Burma (*Mem. Geol. Surv. India*, 1912, **40**, Part I.) E. H. Pascoe gives an exhaustive account of the information available on this subject, including a bibliography. The memoir also includes a bibliography relating to oil occurrences in other parts of the Indian Empire. Works previously published by the Survey on the Burma oilfields are "The Occurrence of Petroleum in Burma and its Technical Exploitation," by F. Noetling (*Mem. Geol. Surv. India*, 1897, **27**, Part II.), and "The Geology of Parts of the Myingyan Magwe and Pakokku Districts, Burma," by G. E. Grimes (*Mem. Geol. Surv. India*, 1898, **28**, Part I.). A considerable amount of information has been accumulated since the issue of those publications, and Mr. Pascoe, who spent four field

seasons between 1905 and 1909 collecting notes on this subject, has brought the information up to date in his memoir. The memoir includes a chapter on the origin of petroleum, which is of special interest in view of the fact that certain workers have regarded the evidence provided by the oilfields of Burma as supporting the hypothesis that the petroleum there is of inorganic or deep-seated origin. Mr. Pascoe finds no evidence in the Burma fields to support the inorganic view, and he concludes that the oil is of organic origin, and probably formed from plant rather than from animal remains. He recounts instances of the association of coal and petroleum, and attributes to these a common origin, local conditions determining the nature of the change. "Where conditions were eminently favourable for the formation of coal, they apparently were not so for petroleum, since beds bearing thick seams of coal are apt to contain little or no petroleum; on the other hand, where conditions did not permit of more than thin layers and local patches of lignite or coal being formed, larger quantities of oil are liable to be found—one is tempted to say 'instead of coal.'" Mr. Pascoe also concludes that the oil has been formed *in situ*, *i.e.* in the beds in which it occurs, and that it does not owe its present position to "upward migration."

Silver Ore.—The Ontario Bureau of Mines (Toronto, 1913) has issued a fourth edition of W. G. Miller's monograph on *The Cobalt-nickel Arsenides and Silver Deposits of Temiskaming*. Some features have been treated more fully in this edition, underground work in the mines having furnished many details concerning the structural relations and the character of the veins. Advantage has been taken of this information to prepare several cross sections and other illustrations, which will add interest to the report.

The deposits dealt with in this monograph are in some respects unique. This area is not only the world's greatest producer of silver, but it controls the market for cobalt, has a large output of arsenic, and is among the three or four areas that have the largest output of nickel.

It is of interest to note that these deposits were discovered as recently as 1903, during the building of the Temiskaming and Northern Ontario Railway, which runs almost over the top of one of the most important veins. The Sudbury nickel deposits, ninety miles south-west of Cobalt, which are the most important in the world, were discovered much in the same way, during the construction of the Canadian Pacific Railway.

NOTICES OF RECENT LITERATURE

THE ROMAN AND THE BRITISH EMPIRES. Two Historical Studies by James Bryce. Pp. 138, Demy 8vo. (London: Oxford University Press, 1914.) Price 6*s.* net; post free, United Kingdom 6*s.* 4*d.*, abroad 6*s.* 5*d.*

Under this general title, Mr. James (now Viscount) Bryce re-issues two essays which were published some years ago in the volumes entitled *Studies in History and Jurisprudence*: "The Ancient Roman Empire and the British Empire in India," and "The Diffusion of Roman and English Law throughout the World." In this more accessible form, the topics dealt with will appeal to those making a special study of Imperial organisation. On the historical side, it is interesting to note, in the words of this high authority, that "it was really from internal maladies, from anæmia or atrophy, from the want of men and the want of money, perhaps also from the want of wisdom, rather than from the appearance of more formidable foes, that the Roman dominion perished in the West," and that "British power in India shows no similar sign of weakness" (p. 76). In his legal essay, Lord Bryce, referring to the progress of the world towards uniformity in law, expresses the view that neither Roman law nor English law is likely to overpower or absorb the other, but that fusion is possible "in the course of ages."

KING'S COLLEGE LECTURES ON COLONIAL PROBLEMS. Edited by F. J. C. Hearnshaw, M.A., LL.D. Pp. xiii + 252, Crown 8vo. (London: G. Bell & Sons, Ltd., 1913.) Price 4*s.* 6*d.* net; post free, United Kingdom 4*s.* 10*d.*, abroad 5*s.*

The series of lectures delivered at King's College during the summer term of the session 1912–13 dealt with the following subjects: The Colonies in International Law (Rev. T. J. Lawrence, LL.D.); Native Land and Labour in the South Seas (Sir Everard Im Thurn, K.C.M.G.); Problems of Australian Federation (Sir John Cockburn, K.C.M.G.); The Influence of Science on Empire (Sir Charles Lucas, K.C.B.); The Colonial Reformers of 1830 (Prof. H. E. Egerton); and Problem of an Imperial Executive (Mr. Sidney Low). Mr. Harcourt, Secretary of State for the Colonies, supplies a Prefatory Note; whilst, in the Introduction to the series, it is stated that the lectures are to be followed up during the coming session, and that Mr. Sidney Low has been appointed lecturer in Imperial and Colonial History for the year. The problems dealt with in the present volume are for the most part problems of the past, but Mr. Sidney Low boldly faces some prob-

lems of the future, from the point of view of a publicist, and deals with these in an interesting manner.

Such a scheme of Imperial studies is obviously of public utility; but it would gain greatly in force if, in place of detached problems—more or less of academic interest—each series in the future were directed to the elucidation of some central problem of Imperial Organisation, such as might be supposed to claim the attention of an Imperial Council.

Guide to the Principal Parliamentary Papers Relating to the Dominions, 1812–1911. Prepared by Margaret I. Adam, J. Ewing, and J. Munro. Pp. viii + 190, Med. 8vo. (Edinburgh: Oliver & Boyd, 1913.) Price 3*s.* 6*d.*; post free, United Kingdom 3*s.* 10*d.*, abroad 4*s.*

This guide will be of great value to any one who may have occasion to study the history of the development of any of the over-seas Dominions.

The contents are arranged geographically in the order Canada, Newfoundland, Australia, New Zealand, South Africa, followed by two sections giving the titles of papers dealing with Emigration and Colonisation, and finally of miscellaneous papers relating generally to the Dominions. For each paper the session, volume, number of paper, and the numbers of the first and last pages are given, followed by the title of the paper and a brief statement of its contents. In the preface to the volume there is a very useful note by Mr. Austin Smyth, on the origin and history of Parliamentary Papers. The volume is provided with a good index.

The Teaching of Indian History. By William Holden Hutton, B.D. Pp. 29, Demy 8vo. (Oxford: at the Clarendon Press, 1914.) Price 1*s.*; post free, United Kingdom and abroad, 1*s.* 1*d.*

This is Mr. Hutton's inaugural lecture as Reader in Indian History in the University of Oxford. Beginning with an appreciatory reference to his predecessor, Mr. Sidney Owen, the lecturer quoted Lord Acton's declaration "that if we lower our standard in history, we cannot uphold it in Church or State," as an ideal which should be constantly before the eyes of historical students, and as a warning never more needed than in the study of British India. The lecturer went on to refer to some of the more important advances in our knowledge of Indian history made in recent years, and to indicate some of the subjects on which ample material awaits research by students who propose to specialise in this subject.

Mr. Hutton concluded with an eloquent appeal for better provision for the study of Indian subjects at the University, and particularly for Indian history (the present

Readership is confined to the history of India since the British occupation), urging that such studies would do much to create a race of British officials understanding the Indian character, and therefore able to deal with the difficult problems which the government of India will present in the near future.

INDIEN. Handbuch für Reisende. Von Karl Bædeker. Mit 22 Karten, 33 Plänen, und 8 Grundrissen. Pp. lxxiv + 358, Small 8vo. (Leipzig: Karl Bædeker, 1914.) Price, M. 20; post free, United Kingdom 20*s.* 4*d.*, abroad 20*s.* 6*d.*

This compact handbook, primarily intended for the German traveller, with little leisure to linger by the way, covers the principal routes followed by tourists in India and Ceylon, and flying visits to Burma, the Malay Peninsula, Siam, and Java. It contains also the usual introductory matter for the aid of travellers, a description of the voyage out, and a general survey of India. The spelling of Indian place-names is based on the *Imperial Gazetteer of India*, with some German equivalents in pronunciation. The maps are excellent.

The practical and up-to-date information contained in this guide is admirably arranged, and should be serviceable to travellers making a voyage round the world.

EGYPT IN TRANSITION. By Sidney Low. With an Introduction by the Earl of Cromer, G.C.B. Pp. xxiv + 290, Demy 8vo. With portraits. (London: Smith, Elder & Co., 1914.) Price 7*s.* 6*d.* net; post free, United Kingdom 7*s.* 10*d.*, abroad 8*s.* 2*d.*

We do not know of any book on modern Egypt since Milner's classic *England in Egypt* (1894) which conveys, in popular form, a more vivid and accurate impression of the regeneration of the Nile Valley than Mr. Sidney Low's contribution to the subject. The period of transition covered in his survey is said to be "between the reconquest of the Sudan by Lord Kitchener and his return to Cairo as British Agent and Consul-General"; and in this survey the greater—as well as the more interesting—part of the volume is devoted to the Sudan under the Anglo-Egyptian Condominium. The title requires this explanation. On the main causes that have contributed to the remarkable progress achieved in the Sudan under the Sirdar and Governor-General, Sir Reginald Wingate, the introduction by Lord Cromer supplies an interesting commentary.

The Egypt of Mr. Sidney Low is essentially the Egypt so well known to us in the series of annual reports by Lord Cromer: it reflects the correct official attitude of the Protectoral Power towards Egypt, regarded as a province of the Ottoman Empire; and, like Lord Cromer himself,

our author favours the adoption of steps towards the abolition or modification of the Capitulations, which do not hamper the administration of the Sudan. The political and economical situation in the Nile Valley is clearly outlined, and full justice is done to the Civil Services that have been created and so efficiently maintained. The native element, too, is dealt with in a sympathetic and judicious spirit, evincing a mastery of facts which the writer has personally investigated on the spot, and not taken at second-hand. Mr. Low writes with judgment, reserve, and with that immediate penetration to the heart of a problem which comes from intensive study and wide experience. His descriptive passages, both of scenery and native life, are not the least admirable feature of a remarkable book; and even those who are interested in Egypt only as a winter resort will find much to attract them.

A Report on the Land Settlement of the Gezira (Mesellemia District). By H. St. G. Peacock. Pp. 68, Imper. 8vo. (London: Sifton Praed & Co., 1913.) Price 3*s.*; post free, United Kingdom 3*s.* 4*d.*, abroad 3*s.* 5*d.*

The Gezira, or island, is the triangular tract of country formed by the Blue Nile and White Nile in the Anglo-Egyptian Sudan. The area is of special importance at the present time, since, as already mentioned in this Bulletin (1913, **11**, 189), the irrigation of a portion of it is being undertaken, with a view to the more extended cultivation of cotton, cereals, and other crops.

The present report was written for the most part in 1910, and is divided into three main portions. The first of these gives a brief history of the Gezira, from the time when it is believed to have been part of a Christian kingdom down to April 1898, when the tribes of the Gezira announced their willingness to submit to Lord Kitchener's army, which had then advanced as far as Atbara. The second portion explains that the object of the Land Settlement was to form a Register of Title as a preliminary to the development of the country by railways and irrigation. It gives a detailed account of how the work was done, describes the progress made in each of the years 1906 to 1910, and mentions some of the curious difficulties encountered in determining the ownership of lands. The last section describes the condition of the country in 1910 as regards population, communications, rainfall, capital and credit, and other similar matters.

The report is provided with a number of good maps and contains a large number of pictures of typical scenes met with during the work of registration. In view of the work of economic development now in progress the Gezira is likely to attract a good deal of attention, and

this report will be of great value as affording useful and accurate information on many points of economic interest.

British Somaliland. By R. E. Drake-Brockman, M.R.C.S., L.R.C.P. Pp. x + 334, 8vo. (London: Hurst & Blackett, Ltd., 1912.) Price 12*s*. 6*d*. net; post free, United Kingdom 12*s*. 11*d*., abroad 13*s*. 3*d*.

My Somali Book: A Record of Two Shooting Trips. By Captain A. H. E. Mosse, F.Z.S., Indian Army. With an Introduction by Col. H. G. C. Swayne, R.E., F.Z.S. Pp. xxvi + 314, 8vo. (London: Sampson Low, Marston & Co., Ltd., 1913.) Price 12*s*. 6*d*. net; post free, United Kingdom 12*s*. 11*d*., abroad 13*s*. 4*d*.

Though Somaliland is a depressing place from a political, and perhaps also from a military point of view, it possesses great attractions for the naturalist, whether he specialises on the fauna or the flora. Dr. Drake-Brockman also shows that its history is by no means devoid of interesting problems; but perhaps the most remarkable feature of his book is the amount of space devoted in one way or another to the economic plant and animal resources of the country. He has contributed in no small degree to our knowledge of these subjects, and in another portion of this Bulletin (p. 11) a report on the gums, gum-resins, and resins of Somaliland is published, dealing with material collected by him.

Matters of more general interest in regard to Somaliland are, however, not neglected by the author, and the chapters describing the coast towns and those dealing with the "Mad Mullah," the outcast tribes, the Somali character, to mention a few of them, are full of interesting matter, as is to be expected from so keen an observer.

A useful sketch-map of the country and numerous excellent illustrations are provided.

As is indicated in the sub-title of his book, Captain Mosse is mainly concerned with Somaliland as a big-game country, and of his seventeen chapters twelve are occupied with racily written accounts of his experiences in two shooting expeditions undertaken in 1907 and 1909, while the interior of British Somaliland was still open. It is interesting to note that he agrees with Dr. Drake-Brockman that the Somalis' principal faults are vanity and avarice, and that apart from these weaknesses they have many estimable qualities.

A long chapter is devoted to the question of protective colouration in animals, the author taking the view that, "while perhaps the majority of the larger mammals, at the present day and under existing conditions, can no longer be considered to benefit from the concealing effect

of their colouration; yet that fact is not in itself any reason for rejecting the theory that the necessity for concealment has been in all probability the most important factor in establishing the existing schemes of colouration amongst animals."

The last two chapters deal with the equipment and arrangements for big-game shooting expeditions and with the factors which determine the value of rifles to be used in such expeditions.

The book is embellished with a number of good reproductions of photographs and with many pen-and-ink sketches: the photographs being by the author and the sketches by Lieut. Haskard, R.A.

Pioneers in South Africa. By Sir Harry Johnston, G.C.M.G., K.C.B. With eight coloured illustrations by Wal Paget. *Pioneers of Empire Series.* Pp. vii + 316, 8vo. (London: Blackie & Son, 1914.) Price 6*s.*; post free, United Kingdom 6*s.* 5*d.*, abroad 6*s.* 9*d.*

The task which Sir Harry Johnston has accepted, in the production of a series of readable books dealing with pioneer work and adventure in the discovery and opening up of countries of the British Empire, is admirably performed in the volume for South Africa. Both in his historical retrospects and physical descriptions the author displays a mastery of detail on a subject he has made his own, in the development of Africa; and the reader is presented with a survey that will live in his memory, aided as this is by admirable illustrations in colour and in black-and-white. His excursions into botany and zoology might perhaps have been shorter, and one is somewhat surprised to find Livingstone referred to as "a martyr" (p. v); but, with these slight reserves, we have no further comment to make on a work which cannot fail to add to the popularity of the series, save to note the absence of an index.

A Historical Geography of the British Colonies. By Sir C. P. Lucas, K.C.B., K.C.M.G. Vol. IV.: South Africa. *New Edition.* Part I., History to 1895. Pp. viii + 331. Part III., Geographical, revised by A. Berriedale Keith, D.C.L. Pp. iv + 332. Crown 8vo. (Oxford: Clarendon Press, 1913.) Price 6*s.* 6*d.* each; post free, United Kingdom 6*s.* 10*d.*, abroad 7*s.*

The immense advances and profound changes in the development and reconstruction of the British Colonies in South Africa have necessitated the recasting and comprehensive revision of Vol. IV. of this series, dealing with South and East Africa, whilst the emergence of the Union of South Africa, no less than the progress and advance in status of the other self-governing Dominions, renders the general title of the series subject to qualification at the

present day. The new edition of Vol. IV. is now issued in two parts, as given above; and Sir Charles Lucas has in preparation a further volume containing the history of South Africa subsequent to 1895, including the War. The volume on Central and East Africa (VII.) will be published separately. The issue of these two new volumes, and the promise of a third by the editor of the series, will be cordially welcomed by a wide circle of students and readers to whom the work is indispensable as a source of reference. But, whilst the historical section is richly illustrated by a new and practical series of sketch-maps by Mr. B. V. Darbishire, only one such map is provided for the geographical survey in the new edition.

A HISTORICAL GEOGRAPHY OF THE BRITISH COLONIES. By Sir C. P. Lucas, K.C.B., K.C.M.G. Vol. III. West Africa. *Third Edition*, revised to the end of 1912 by A. Berriedale Keith, D.C.L. Pp. 427, Crown 8vo. (Oxford: Clarendon Press, 1913.) Price 8*s.* 6*d.*; post free, United Kingdom 8*s.* 10*d.*, abroad 9*s.* 1*d.*

Fourteen years have elapsed since the preparation for press of the second edition of this volume, in the valuable series to which it belongs; and, during recent years, progress in Colonial development has been so marked in West Africa, that a new edition was urgently required. The work of revision and enlargement has been carried out by Dr. Berriedale Keith, author of *Responsible Government in the Dominions* (see this BULLETIN, 1912, **10**, 515), and new sketch-maps by Mr. B. V. Darbishire replace the coloured maps of the earlier editions. Two new chapters on West Africa in the Twentieth Century deal with the progress made in administrative control and with the improvements in trade and health conditions, in the opening up of these countries to European commerce and settlement.

THE SULTANATE OF BORNU. Translated from the German of Dr. A. Schultze. With additions and appendices. By P. Askell Benton, B.A., F.R.G.S. Pp. 401, Small 8vo. (London: Humphrey Milford, Oxford University Press, 1913). Price 7*s.* 6*d.* net; post free, United Kingdom 7*s.* 10*d.*, abroad 7*s.* 11*d.*

The translation into English of Dr. Schultze's monograph—the first of its kind—on this ancient Sultanate of the Central Sudan was well worth undertaking, in view of the somewhat scattered literature on the subject and of the importance of this region—or the greater part of it—under the recently created Governor-Generalship of Nigeria; and, although Mr. Benton expressly confesses his ignorance of the German language, the result, with such assistance as he was able to enlist, is eminently satisfactory. We are presented with a very readable—and, so far as we have tested

it, accurate—account of the physical conditions of this interesting inland drainage-area and of its ancient history, of its opening up to the policy of Europe by the travels of many distinguished British and German explorers, and of the conditions and commercial prospects now existing. There are no less than 21 appendices, occupying nearly one-half of the book, some of which seem redundant; and the two maps are printed from the same plates as those for the German edition.

The New World of the South. The Romance of Australian History. By W. H. Fitchett, B.A., LL.D. Pp. viii+428, Crown 8vo. (London: Smith, Elder & Co., 1913.) Price 6*s.*; post free, United Kingdom 6*s.* 4*d.*, abroad 6*s.* 6*d.*

Dr. Fitchett's second volume, under the same title as the volume previously noticed (see this Bulletin, 1913, **11**, 372), deals with romantic incidents in Australian history grouped under headings which indicate their historical connection with the development of Australia, up to the birth of the Commonwealth. But, in this supplementary volume, there is little continuity of treatment, except under geographical discovery, until Book IV. (p. 385) is reached, when the political evolution of the Federating Colonies is briefly outlined. The bulk of the book is frankly devoted to stories of the second generation of bushrangers, whose stirring adventures had little effect on the making of history. As in the previous volume, the treatment of geographical exploration is to be specially commended.

The Barbados Handbook, 1914. By E. Goulburn Sinckler. Pp. xii+233, Demy 8vo. (London: Duckworth & Co., 1914.) Price 2*s.* 6*d.* net; post free, United Kingdom 2*s.* 10*d.*, abroad 3*s.* 2*d.*

Reference to this excellent Handbook has already been made in this Bulletin (1912, **10**, 343). The present volume forms the third edition, and covers essentially the same ground as its predecessors, but the opportunity has been taken of extending considerably the section devoted to the history of Barbados, which is now brought down to current times. This feature is of no small historical value, since Sir R. Schomburgh's *History of Barbados* deals only with the period down to 1846. It will be sufficient to add that the excellent printing, illustrations, and appearance of the former editions are fully maintained.

Elementary Tropical Agriculture. By W. H. Johnson, F.L.S. Pp. xi+150, Demy 8vo. (London: Crosby, Lockwood & Son, 1913.) Price 3*s.* 6*d.* net; post free, United Kingdom 3*s.* 10*d.*, abroad 3*s.* 11*d.*

In his preface to this volume, the author explains that the book is intended for use in connection with the study

of the principles of agriculture in West African schools, and that he hopes it will prove useful for a similar purpose in other tropical countries.

From the outset Mr. Johnson assumes that the school will have a garden and that agriculture can only be taught with the aid of experiments carried on by the students themselves. With this primary condition constantly in mind, he discusses in simple language the formation and composition of soil and the principles which underlie modern methods of utilising soil to the best advantage. He then goes on to the various parts of a plant, dealing in the same way with their structure and functions, and concludes the first portion of the book with two useful chapters on fungoid diseases and insect pests. The second portion consists of three chapters dealing with the formation and care of the school garden, including suggestions as to the crops that should be grown in it. Throughout the book simple experiments, well designed to illustrate the points which it is sought to demonstrate, are suggested, and the plants and materials employed for the experiments are always such as are readily obtainable in West Africa, and indeed throughout the greater part of the tropics. Numerous illustrations are provided, mostly original line drawings prepared by the author's colleague, Mr. Peacock, lately Entomologist in the Department of Agriculture of Southern Nigeria.

The book is clearly intended for native students working under a teacher, who may be assumed to be familiar with the weak points of local native farming. For that reason, no doubt, no special emphasis is laid on the necessity for a complete change in certain practices which are almost characteristic of native farming throughout the tropics. It is a nice point whether it is better to condemn bad practice to a student or to teach him sound principles and leave him to discover and avoid bad practice for himself. The author is probably quite correct in thinking the latter the better method.

Mr. Johnson points out in his preface that the best method of removing the antipathy exhibited by educated West African natives to agriculture is to make the latter a specific subject in the native school course. This is a good suggestion, and in providing this serviceable text-book the author has made it distinctly easier to put his suggestion into practice.

THE DISEASES OF TROPICAL PLANTS. By Melville Thurston Cook, Ph. D. Pp. xi + 317, Demy 8vo. (London: Macmillan & Co., 1913.) Price 8*s.* 6*d.* net; post free, United Kingdom 8*s.* 11*d.*, abroad 9*s.* 3*d.*

In this volume the author has attempted the very difficult task of preparing a handbook on the fungal diseases

affecting the economic plants of the tropics. The immense number of such diseases, the lacunæ in our information regarding a large proportion of them, and the varying character of the problems concerned in different parts of the tropics, render the work of special magnitude, to which justice cannot be done in some three hundred pages, many of which are concerned with preliminary or accessory matter. The author, however, has provided a useful introduction to the subject. The book is intended primarily for planters, and the arrangement has been planned accordingly. Introductory chapters deal with the nature and symptoms of plant diseases, the structure and functions of plants, and give a useful classification of fungi; while special sections deal with practical questions of prevention and control, the preparation of fungicides, and the manipulation of spraying apparatus.

The body of the book is concerned with the description of specific diseases. The treatment is non-technical rather than "popular," but the planter has not been spared in the use of scientific names, the careful record of which renders the book of value to students, who will also find the bibliography of important papers a useful introduction to the extensive literature of the subject. Reference must be made to the excellent character of the great majority of the illustrations, which are in somewhat sharp contrast with the diagrams provided in the preliminary chapters.

Mildews, Rusts, and Smuts. By George Massee, assisted by Ivy Massee. Pp. 229, Demy 8vo. (London: Dulau & Co., 1913.) Price *7s. 6d.* net; post free, United Kingdom *7s. 10d.*, abroad *8s.*

In this book, which comprises a synopsis of Peronosporaceæ, Erysiphaceæ, Uredinaceæ, and Ustilaginaceæ, the authors have kept two objects in view, viz. to afford an account of modern views in regard to the important groups mentioned; and to facilitate the identification of fungi included in them. Both these objects would appear to have been accomplished, and the volume should be of considerable assistance to the increasing number of students of economic mycology. The plan of the work is on the usual lines, which are of proved utility. A general account of the family is succeeded by brief notes on the genera, which are subsequently differentiated by means of a "key." The species are then described, details of synonymy and information regarding host-plants being provided. Species other than those already found in this country are included—a desirable feature in view of the frequency of new records. The book concludes with an index of genera and species, and a list of host-plants. There is a coloured frontispiece, and a number of line drawings are arranged in four plates. The binding and format of the book are on

thoroughly practical lines, a matter of importance in a work of reference.

Planting in Uganda: Coffee, Para Rubber, Cocoa. By E. Brown, F.L.S., and H. H. Hunter, LL.D. With contributions by Professor Dunstan, C.M.G., etc., and Mr. George Massee, F.L.S. Pp. xvi + 176, Demy 8vo. (London: Longmans, Green & Co.; Dublin: The Talbot Press, 1913.) Price 10*s.* 6*d.*; post free, United Kingdom 10*s.* 10*d.*, abroad 11*s.* 2*d.*

It has been pointed out already in this Bulletin that British planters are less fortunate than many of their foreign competitors, in the fact that comparatively few books on tropical agriculture and tropical crops have been published in English. The books in English that have appeared dealing with these subjects have usually been compiled on the Continental plan of devoting a book to a single crop, such as rubber, cocoa, coconuts, etc., or to a group of closely allied products, as in the case of Mr. Ridley's book on *Spices*. Mr. Brown and Dr. Hunter have adopted a new plan, viz. that of dealing with a few crops in a particular area. There is much to be said for this from the planter's point of view, since only in this way can the influence of local peculiarities on particular crops be adequately discussed, within a reasonable space.

This novel feature of the book now under notice is probably responsible for the rather unusual mode adopted in discussing the three crops considered. The first chapter is quite general and deals with the physical features of the country; the next is devoted to the history of the three crops in Uganda; and the remaining chapters deal in logical sequence with such subjects as the choice of land for plantations, nurseries, laying out plantations, clearing and planting, upkeep, factory and machinery, organisation of estates, etc., the novel feature being that at each stage in this transition the three crops are discussed seriatim in the same or subsequent chapters. This plan makes it a little difficult to follow each crop through all its stages, but it has certain practical advantages from the planters' point of view, and, after all, that should be the main consideration in a book of this kind. Mr. Massee contributes a useful chapter on the fungoid diseases of cocoa, coffee, and Para rubber, and Prof. Dunstan provides an introduction in which he directs attention to the useful work in tropical agriculture done in Uganda by the small establishment of scientific officers, which has recently become the Agricultural Department of the Protectorate. The book is very well produced, and contains a large number of excellent illustrations, mostly reproductions from photographs. It should be of great value to the small but enterprising body of European planters in Uganda.

THE BANANA: ITS CULTIVATION, DISTRIBUTION, AND COMMERCIAL USES. By William Fawcett, B.Sc. (Lond.), F.L.S., With an Introduction by Sir Daniel Morris, K.C.M.G., D.Sc., D.C.L., F.L.S. Pp. xi + 287, Demy 8vo. (London: Duckworth & Co., 1913.) Price 7*s.* 6*d.* net; post free, United Kingdom 7*s.* 10*d.*, abroad 8*s.*

In the introduction to this work, Sir Daniel Morris draws attention to the magnitude of the banana industry, and refers to the fact that its rapid and enormous growth was due to the discovery of the means of transporting the fruit successfully in cold storage.

The book gives a complete account of the banana, including a description of the plant, the methods of planting, cultivating and harvesting the crop, the pests and diseases by which it is liable to be attacked, the development of the banana trade, and the by-products of the industry.

The chapters on the general cultivation of the plant deal with the methods employed in Jamaica, where the author has been in close touch with the industry for many years. In later chapters, however, reference is made to the practice of other countries, viz. India and Ceylon, the Malay Archipelago, the Philippine Islands, Australia, Polynesia, Africa, South America, Central America and the United States, and the West Indies and Bermuda. It is pointed out that the bananas of Jamaica and Central America are derived from cultivated varieties of *Musa sapientum*; those of the Canary Isles from *M. Cavendishii*, and those of the Malay region from *M. acuminata* and *M. sapientum*. Plantains are derived from *M. paradisiaca*; they are not exported to the United Kingdom, and only in small quantities to the United States.

The costs of cultivation and the returns which may be expected are dealt with, and the prospects are discussed of those undertaking banana planting for the first time. An account is given of the production of Manila hemp and other fibres derived from various species of Musa. A short chapter is devoted to species of Ravenna, Strelitzia, and Heliconia, which are allied to the banana plant, and another gives a brief description of the numerous species of Musa. Information is supplied on the preparation of dried bananas and banana flour, and the manufacture of wine, whisky, and alcohol from the fruit, and, in a short appendix, a series of recipes is given for cooking bananas. The commercial aspect of the industry is well treated, and interesting details are given of the methods of transporting the fruit both by land and sea.

The book is written in a clear and interesting manner, contains some excellent illustrations, and can be recommended as a valuable treatise on every phase of the banana industry.

THE TEXTILE FIBRES: THEIR PHYSICAL, MICROSCOPICAL, AND CHEMICAL PROPERTIES. By J. Merritt Matthews, Ph.D. *Third Edition.* Pp. xi + 630, with 141 figs., Demy 8vo. (New York: John Wiley & Sons; London: Chapman & Hall, Ltd., 1913.) Price 17*s.* net; post free, United Kingdom 17*s.* 6*d.*, abroad 18*s.*

This valuable work, which has now reached its third edition, gives an account of the various fibres employed in the textile industries. The word "textile" is used in its widest significance, the fibres dealt with including not only the textile fibres proper, but also those employed for cordage manufacture, brush-making, and upholstery. The greater part of the book is devoted to an account of the physical and microscopical characters and the chemical composition and reactions of the fibres, but considerable space is also allotted to the bearing of these properties on the industrial utilisation of the products. Distinctive tests are recorded for the recognition and identification of the various fibres, and schemes of analysis are provided for their detection and estimation, both in mixtures and also in yarns and fabrics. The work is well illustrated, and contains a useful bibliography.

The new edition has been thoroughly revised and brought up to date, and contains many important additions. There is no doubt that the various improvements will render it of increased utility both to those practically engaged in the textile industries and also to students and others interested in the subjects with which it deals.

DIE JUTE: IHRE INDUSTRIE UND VOLKWIRTSCHAFTLICHE BEDEUTUNG. By Richard Wolff. Pp. 147, Med. 8vo. (Berlin: Franz Siemenroth, 1913.) Price M. 6; post free, United Kingdom 6*s.* 4*d.*, abroad 6*s.* 6*d.*

This work deals mainly with the manufacturing industries which depend on jute as their raw material. A short account is given of the production of the fibre in India and other countries, and of the attempts to discover suitable substitutes for it, both natural and artificial. In this connection it is unfortunate that the author refers to China jute as a true jute, instead of a substitute, thus leading the reader to suppose that it is derived from a species of Corchorus, whereas actually it is the fibre of *Abutilon Avicennæ.* The trade in raw jute, and the fluctuations in price of the fibre and of yarns and fabrics manufactured from it, are discussed, and are illustrated by several statistical tables and diagrams. The remaining chapters are devoted to an account of the jute-manufacturing industries of India, the various European countries, Brazil, Japan, and the United States of America. The book is a useful compilation and a valuable exposition of the economic importance of jute.

COCONUTS: THE CONSOLS OF THE EAST. By H. Hamel Smith and F. A. G. Pape. 2nd Ed. With forewords to both editions by Sir W. H. Lever, Bart. Pp. lxviii + 644, Crown 8vo. (London: John Bale, Sons, & Danielsson, Ltd., 1914.) Price 12*s.* 6*d.* net; post free, United Kingdom 12*s.* 11*d.*, abroad 13*s.* 3*d.*

Reference to the first edition of this useful work was made in this BULLETIN (1913, **11**, 522). The book has now been revised and enlarged. The additions include an account of the costs of manufacturing copra, and sections on (1) a fungus parasitic on the larvæ of coconut beetles, (2) the breeding of horses on coconut estates, (3) the manufacture of butter substitutes from coconut oil, (4) coconut cultivation in the Solomon Islands and in Fiji, and (5) the use of dynamite for breaking up hard soils and removing rocks and tree stumps and for other purposes in the establishment of coconut plantations. The section on the manufacture of coir has been rewritten and brought up to date.

EVAPORATION IN THE CANE AND THE BEET SUGAR FACTORY. A Theoretical and Practical Treatise. By Edward Koppeschaar, formerly Technical Manager of the Vierverlaten Sugar Factory, Holland. Pp. viii + 116, Roy. 8vo. (London: Norman Rodger, 1914.) Price 7*s.* 6*d.* net; post free, United Kingdom 7*s.* 10*d.*, abroad 8*s.*

This work deals with the principles of evaporation, particularly in relation to the requirements of the sugar industry, and also gives an account of the various forms of evaporating plant, the methods of control, and the different calculations required in connection with the processes of evaporation involved in sugar manufacture.

The book is well provided with plates, plans, and diagrams, and contains some useful tables. It will doubtless prove of considerable service to factory managers, engineers, and others employed in sugar mills.

A COURSE OF PRACTICAL WORK IN THE CHEMISTRY OF THE GARDEN. By D. R. Edwardes-Ker. Pp. 40, Crown 8vo. (London: John Murray, 1914.) Price 1*s.* 6*d.* net; post free, United Kingdon and abroad, 1*s.* 8*d.*

This book describes a number of simple experiments for the detection of the principal constituents of plants, soils, and manures, and concludes with a chapter on the preparation of sprays and washes. Exception may be taken to a few statements in the book, such as the one which ascribes *astringent* properties to quassia, and another which refers to "lime sulphur" as a *new* fungicidal wash.

The experiments are well selected with a view to affording an insight into horticultural chemistry, and the book will be useful both to teachers and students of gardening and rural science.

THE CHEMISTRY OF CATTLE FEEDING AND DAIRYING. By J. Alan Murray, B.Sc. (Edin.), Lecturer in Agricultural Chemistry at University College, Reading. Pp. xii + 343, Crown 8vo. (London: Longmans, Green & Co., 1914.) Price 6*s.* net; post free, United Kingdom 6*s.* 4*d.*, abroad 6*s.* 8*d.*

In Parts II. to IV. of this work, which should prove very valuable to students of agricultural chemistry, a critical study is made of the subjects of cattle feeding and milk production, and of the value of different feeding stuffs. These subjects are discussed by means of calculations based on the composition of the different foods, their digestibility, and the quantities of heat and work they can produce when oxidised in the animal body, and on the increase in body weight of a growing or fattening animal, and on the yield of milk. Part I., which extends to p. 97, deals with the constituents of plants and animals, and is intended to be used for reference, as the information it gives is in a very condensed form.

This work shows that one problem now calling for solution is as to how the proteins of the food are converted into the tissues and materials of the animal body, and the value of different proteins for this purpose. Formerly, in comparing foods, it had to be assumed that one protein was as good as another, but now the difference in their natures is attracting attention; thus mice died of nitrogen starvation when zein, a protein of maize, was the only nitrogenous constituent of their food. It is thought that any single vegetable protein is inadequate, but that by supplying a mixture of foods those nitrogenous groups necessary for the animal will be provided.

BRITISH AND COLONIAL DAIRYING FOR SCHOOL, FARM, AND FACTORY. By G. Sutherland Thomson, F.R.S.E., with an Introduction by J. A. Ruddick, Dairy Commissioner for Canada. Pp. xi+464, Demy 8vo. (London: Crosby, Lockwood & Son, 1913.) Price 5*s.*; post free, United Kingdom 5*s.* 5*d.*, abroad 5*s.* 10*d.*

This manual of dairying in all its branches affords striking evidence of the high standard of excellence now required in this important branch of agriculture.

In the first chapter the author discusses the milk supply, and emphasises an important point, no doubt often forgotten, viz. that the contamination of milk, and therefore the spread of disease, can as often be traced to the carelessness of milk consumers as to unhealthy cows. Householders, he contends, should be made to realise their own responsibilities in this matter, which would tend to reduce mortality from tubercular disease communicable through the milk supply.

There is a long chapter on butter production, in the

course of which the author refers to the gradual decrease of butter exports from the Dominions to the United Kingdom during recent years, and its effect on the home trade, which has been to raise the price of butter without any corresponding improvement in quality, with the net result of stimulating the sale of margarine. This product now comes into active competition with butter, especially the lower grades; but Mr. Thomson considers that the best brands of margarine will soon be on a level with first-class butter.

An important section in the book is that dealing with the rearing and breeding of stock. In that treating of the development of the dairying industry some striking figures relating to the expansion of the industry, in the colonies and elsewhere, are given. In Australia, for example, the output of butter has more than doubled in the past ten years.

The book is well illustrated and well produced, and is written in a style which will appeal to those practically concerned in the dairy industry both at home and in the overseas Dominions.

A PILGRIMAGE OF BRITISH FARMING, 1910–12. By A. D. Hall, M.A., F.R.S. Reprinted by permission from *The Times*. Pp. xiii+452, 8vo. (London: John Murray, 1913.) Price 5*s.* net; post free, United Kingdom 5*s.* 4*d.*, abroad 5*s.* 7*d.*

In the latter part of the eighteenth century, Arthur Young, a prolific writer on agricultural subjects, whose labours were of the greatest value to British agriculture, published his *Farmer's Tours in England, Wales, and Ireland*. In the introduction to one of these he writes, " Practices that are found highly advantageous in one district are totally unknown in another, although the soil, exposure, climate, etc., be exactly the same. The farmers in one place grow rich by methods which would enrich their brethren in another, but which remain quite unknown. Can it be thought useless to render all such local knowledge general? To let each cultivator see all the different methods that are practised upon such land as his own? . . . It is the design of this little register to spread useful knowledge of all sorts, to display to one part of the kingdom the practice of the other, to remark wherein such practice is hurtful, and wherein it is commendable."

No better account than this can be given of the present work, from which any one connected with the land is likely to obtain numerous valuable hints for improving his undertaking and increasing its profits, and which is likely to be far more stimulating in ideas that can be put into practice, than a more systematic work on agricultural subjects. The author's past work at Wye, and at the Rothamsted Experi-

mental Station, are a guarantee of the soundness of his views on all the different kinds of farming that he records.

His journeys extended from Cornwall to the Moray Firth, and from Essex to the West of Ireland, and he gives graphic accounts of the farming in the parts he visited, and of the economic position of the farmers. In his conclusions he says that the industry is at present sound and prosperous, and he thinks that further improvement lies in the direction of more co-operative effort amongst farmers in their purchases of materials and sales of produce, and more especially in the formation of groups of farmers raising money on the collective security of the whole body and lending it to members on the knowledge they possess of their character. He remarks that the ordinary farmer needs the more flexible habit of mind that comes with reading, and the susceptibility to ideas that comes from acquaintance with a different atmosphere than the one in which he ordinarily lives; he has little acquaintance with the methods by which other people attain the same ends, and regards his own style of farming as inevitable.

L'Industrie des Pêches sur la Côte Occidentale d'Afrique (Du Cap Blanc au Cap de Bonne-Espérance). Par A. Gruvel. Introduction de M. le Gouverneur général E. Roume. Pp. 193, with 24 plates and 44 figures in the text; Roy. 8vo. (Paris: Émile Larose, 1913.) Price 10 francs; post free, United Kingdom 8*s.* 4*d.*, abroad 8*s.* 8*d.*

Within recent years the appearance of monographs on the resources of West Africa has been a notable feature of the literature that is so rapidly accumulating around these important colonial possessions. The majority of such publications have been concerned with the development of agriculture and the exploitation of forest products; and a very useful purpose is served by the appearance of the present volume, which furnishes a reminder of the existence of other resources, the development of which would add not a little to the physical well-being of the native peoples concerned.

The full title of the book indicates that the fisheries dealt with are those of the geographical "west coast" of Africa, an area which includes the more restricted region commonly referred to under that name. On this coast fishing appears to be carried on for the most part by the natives, chiefly for supplying their personal needs, though in each of the colonies a certain proportion of the inhabitants make a living from fishery work, there being in some a considerable native trade in dried fish. In other colonies the industry is entirely in European or Asiatic hands. The author divides the colonies, irrespective of nationality, into two classes, viz. those producing a supply of prepared fish in excess of their needs, and therefore

permitting the export of a certain quantity; in this class are Dahomey, Angola, and the Union of South Africa; and, the remainder, including Gambia, Sierra Leone, Gold Coast, and Southern Nigeria, in which the demand for fish exceeds the supply.

The bulk of the volume is occupied with descriptions of the methods of production and preparation encountered in each colony; the writer describes in an entertaining manner the fishing grounds, the races of fishermen, their boats, nets, traps, and other fishing appliances, with the modes of use, as well as the fish met with, their preservation, and the native trade and local markets. It is interesting to note that a company of Breton fishermen, formed at Douarnenez, has recently commenced winter fishing operations off the coast of Mauritania and Senegal, the chief centre being Port Étienne. The results have been encouraging, and this example is being followed by other of their compatriots.

The remaining pages of the work are devoted chiefly to a list of the principal edible species of fish, crustaceans, and molluscs of the coast, and to general conclusions. In summing up the whole aspect of the fisheries, the author considers that the native fisheries are best developed in Senegal, Ivory Coast, Gold Coast, and Dahomey; and least so in Southern Nigeria and in French and Belgian Congo. In Togo, Kamerun, and in Spanish Guinea the industry is almost non-existent. Fishing in its European forms is being developed in Mauritania, and to a less extent in Senegal, whilst on the coasts of Angola the methods of fishing and preparation employed in the south of Portugal are being used with success. In the Union of South Africa, where the most modern methods are in vogue, the industry has attained great importance. Finally, the writer thinks that, with improved and more economical methods of fishing and preservation, the fisheries of the west coast of Africa can be made one of the most flourishing and productive industries of this region.

The volume is well illustrated with half-tone plates and text-figures, and has an excellent bibliography, but, unfortunately, lacks a general index.

Manures and Fertilisers. By Homer J. Wheeler, Ph.D., D.Sc. Pp. xxi + 389, Crown 8vo. (New York: The Macmillan Co., 1913.) Price *7s.* net; post free, United Kingdom *7s. 5d.*, abroad *7s. 9d.*

This volume is written by an author who has been associated with the experimental side of his subject in the capacity of Director of the Agricultural Experiment Station of the Rhode Island State College, U.S.A., and with the manufacturing side as chemist to a manure factory in the United States. Methods of manufacture are not discussed

in full, but consideration is given to the composition and effects of practically all substances used as manure, the more important of these being considered in detail. Farmyard manure is fully dealt with, not only as regards its composition, storage, and use, but also as regards its organisms and the influence of these on soil fertility. The influence of lime on soil is adequately considered, and the chapters on the manurial effect of magnesium and sodium salts are of interest. The value of the book is enhanced by the frequent references to original work, particularly that carried out at the Rhode Island Agricultural Experiment Station.

The book is arranged in a manner very convenient for reference, and should prove of value both to agricultural students and to the practical farmer.

Mineral Deposits. By W. Lindgren. Pp. xv + 883. (London: McGraw-Hill Book Company, 1913.) Price 21*s.* net; post free, United Kingdom 21*s.* 6*d.*, abroad 22*s.* 3*d.*

Under the comprehensive title of *mineral deposits*, this book deals with ore deposits, and those other deposits from which useful minerals are obtained, but which have never been given a suitable name correlative with the name *ore deposits*. The designation "mineral deposits" is perhaps as much too wide for the purpose of this book as that of "ore deposits" is too narrow. To restrict its meaning in such a way as to make it suit the scope of his book, Mr. Lindgren defines "mineral deposits" as "geologic bodies which consist mainly of a single useful mineral, or which contain, throughout or in places, valuable minerals that can be profitably extracted." The study of these deposits has been actively carried on in recent years by workers in the United States, including the author himself, who is a well-known authority on this subject.

The manner of treatment adopted in this book is one to which readers of the literature of ore deposits have grown accustomed. It regards mode of origin as the most vital feature in the study of a mineral deposit, and is eminently suited to the requirements of the mining geologist, whose main purpose is, by determining the factors involved in the formation of deposits, to throw what light he can on the problem of their extension in depth, and to ascertain as far as possible the laws that govern their variation.

Lindgren makes physical and chemical factors predominant in his scheme of genetic classification. His two main groups are (I) deposits produced by mechanical processes of concentration (temperature and pressure moderate), and (II) deposits produced by chemical processes of concentration (temperature and pressure vary between wide limits). Group II comprises deposits formed (*a*) in bodies of surface waters, (*b*) in bodies of rocks, and (*c*) in

magmas by processes of differentiation. In the ultimate subdivisions an attempt is made to define the temperature and pressure conditions under which the deposits were formed. Lindgren's view is that "the genetic classification should ultimately determine the limits of ore deposition in each class by temperature and pressure. Each deposit should be considered as a problem in physical chemistry, and the solution of this problem, with the necessary geological data, will suffice to fix the mode of formation of the deposit."

The book has some of the defects that arise from a genetic treatment of the subject, and it is easy to select from its pages illustrations of these defects. For instance, the tin-ore deposits of Cornwall and Saxony get several pages, but those of the Malay Peninsula are dismissed in one small paragraph. Numerous other instances could be cited to show that the book is not intended as a guide to the relative economic importance of deposits, and that all important types of deposits have not received adequate attention by the author. In this connection the reader should remember a remark made in the preface, that "the general plan has been to select a few suitable examples to illustrate each genetic group of deposits."

It is thus for the advanced student and mining geologist that Mr. Lindgren has written his book, which is a valuable and trustworthy guide to the study of "mineral deposits." The book is excellently published, fairly well provided with illustrations and references to recent literature, and no mining geologist can afford to be without it.

Natural Rock Asphalts and Bitumens. By Arthur Danby. Pp. viii + 244, Crown 8vo. (London: Constable and Co., 1913.) Price 8*s.* 6*d.* net; post free, United Kingdom 8*s.* 10*d.*, abroad 9*s.*

The increasing use of asphalt and bitumen in many branches of constructive work renders it desirable to have an up-to-date book dealing with current British practice, and this is the special claim made by the author for the present volume. The subject-matter includes the history, geology, natural occurrence, methods of working, physical properties, testing and uses of the various types of asphalt and bitumen.

It is unusual to find, in a technical work of this description, a chapter devoted to the early history of the subject and recounting the references to it in classical literature, and there is much to be said for this interesting innovation, so long as it is not overdone to the detriment of the technical matter.

The chapter on "Tests and Analyses" needs expert revision. Thus on p. 138 there is a statement to the effect that the mineral matter in asphalts is unchanged when

brought to a constant white heat and maintained at this temperature for a long time; this is incorrect as regards limestone, which is one of the most commonly occurring mineral substances in rock asphalt. After this treatment the residue is to be analysed, and, according to the author, the results obtained will render it possible to determine the place of origin of the bitumen. On p. 140, three methods are given for the estimation of petrolene, viz. (1) extraction with boiling alcohol, (2) steam distillation, (3) heating in a crucible at 250–260° C., until no further loss occurs; but it is not mentioned that these three methods do not give comparable results.

Two chapters are devoted to the technical utilisation of asphalt; the section on asphalt mastic work, written largely by Mr. H. W. Brant, dealing very fully with the subject.

In some respects the book is badly arranged. Thus, the chapter headed "Appearance and Physical Structure" contains matter relating to contract specifications. It is also to be regretted that, as a rule, the author does not give definite references to the authorities whom he quotes.

These defects can be easily remedied in a second edition, and they do not detract seriously from the value of the work to those practically engaged in producing or using asphalt.

The Mining World Index of Current Literature. Vol. iii., first half-year 1913. By G. E. Sisley. Pp. xxvi + 158, Med. 8vo. (Chicago: The Mining World Company, 1913.) Price $1.50; post free, United Kingdom 6*s.* 10*d.*, abroad 7*s.*

This useful bibliography follows the same lines as the previous volumes (see this Bulletin, 1913, **11**, 549), and covers a large variety of subjects connected with mining, including metals and metallic ores, non-metals, mines and mining, mills and milling, chemistry and assaying, metallurgy, power and machinery, and miscellaneous subjects. A new and useful feature is the addition of a list of the publications referred to in the index, including periodicals, books and transactions, bulletins, etc., of schools, societies, and Government departments.

The Science of Burning Liquid Fuel. By William Newton Best. Pp. 159, Med. 8vo. (London: E. & F. N. Spon, Ltd., 1913.) Price 9*s.*; post free, United Kingdom 9*s.* 4*d.*, abroad 9*s.* 7*d.*

This book covers the whole subject of the utilisation of mineral oil for the production of heat to be used for raising steam, for heating ovens and furnaces, and for other like purposes, but does not touch the use of oil in internal-combustion engines, though liquid fuel is perhaps burnt to greater advantage in this than in any other way at present in industrial use.

The author has been engaged, in the United States, in constructing and installing plant for burning oil fuel since 1887, and the information he gives is practical, and likely to be of great value in the installation and working of oil-fuel plants. After discussing the origin and production of liquid fuel, the atomisation of oil, oil-systems, and refractory materials for use in heating by burning oil, the author proceeds to describe oil-fuel equipment for marine, stationary, and locomotive boilers. Finally, ovens and furnaces for a great variety of purposes are dealt with, due attention being given in all cases to difficulties arising from inefficient combustion and other causes, and the means to be taken to avoid or remedy these troubles.

The book is printed in unusually large type, and is provided with numerous illustrations and scale drawings. The latter are clear and neatly arranged, but have been so much reduced in some cases that the explanatory lettering is almost illegible.

Cyanamid: Manufacture, Chemistry, and Uses. By Edward J. Pranke, B.Sc. Pp. vi + 119, Demy 8vo. (Easton, U.S.A.: The Chemical Publishing Co.; London: Williams & Norgate, 1913.) Price 5*s.*; post free, United Kingdom 5*s.* 4*d.*, abroad 5*s.* 5*d.*

During the past five years considerable activity has prevailed in the manufacture of nitrogenous manures from atmospheric nitrogen. One of the most important of these manures is calcium cyanamide, the output of which, during 1913, exceeded 250,000 tons. The widespread use of this product has led to the accumulation of much information regarding its chemical and agricultural properties, and the present volume is published as a review of the knowledge available at the present time.

Various terms are used to designate calcium cyanamide in commerce, and in a note on the nomenclature of the industry it is stated that the trade product is now called "nitrolim" in the United Kingdom, and usually Cyanamid (with the initial letter capitalised) in the United States, although the Department of Agriculture in the United States uses the name "calcium cyanamid." The author of this book restricts the term calcium cyanamide to the pure compound ($CaCN_2$) which is of theoretical interest only.

The author's chapter on the method of preparation of the manure hardly justifies the inclusion of the word "manufacture" in the title, as he describes the whole process, including the preparation of calcium carbide and pure nitrogen, and the packing of the final product, in about three pages.

After a useful summary of the chemical properties of pure calcium cyanamide, cyanamide, and dicyanamide, the

author gives analytical methods for the determination of nitrogen and of several organic compounds which may occur in the manure, but no mention is made of methods applicable to the estimation of the inorganic constituents present. Perhaps the best chapter in the book is the one dealing with the decomposition which "Cyanamid" undergoes in the soil. Here an impartial summary is given of the work carried out during recent years, particular attention being given to the important researches of Ulpiani and Kappen. This chapter, together with the one following, in which the toxicity of the manure is fully discussed, will probably prove the most interesting portions of the book to the agriculturist.

The short chapter on the agricultural use of the manure is disappointing; as although the author devotes two pages to a general discussion of the factors which may cause variations and errors in manurial trials, no adequate comparison is made of the efficiency of the manure, on typical soils, compared with such nitrogenous substances as ammonium sulphate, sodium nitrate or calcium nitrate. Other subjects, to which short chapters are devoted, include the storage and fire risks of "Cyanamid," its use as an ingredient in mixed manures, and the retention of "Cyanamid" nitrogen in the soil.

BOOKS RECEIVED

A View of the Art of Colonization. By E. G. Wakefield. With an Introduction by J. Collier. Pp. xxiv + 510. (Oxford: Clarendon Press.) 5*s.* net.

The Guide to South and East Africa. Edited by A. Samler Brown and G. Gordon Brown. *1914 Edition.* Pp. liv + 695. (London: Sampson Low, Marston & Co.) 1*s.*

The Settler and South Africa. By W. Macdonald, D.Sc. Pp. 159. (London: Union-Castle Mail Steamship Company.) 6*d.*

Beyond the Pir Panjal. By E. F. Neve, M.D. Pp. viii + 178. (London: Church Missionary Society.) 2*s.* 6*d.*

All about Coconuts. By R. Belfort and A. J. Hoyer. Pp. xii + 201. (London: St. Catherine Press.) 6*s.* net.

Coconut Cultivation and Plantation Machinery. By H. L. Coghlan and J. W. Hinchley. Pp. x + 128. (London: Crosby Lockwood & Co.) 3*s.* 6*d.*

The Cultivation of the Oil Palm. By F. M. Milligan. Pp. xii + 100. (London: Crosby Lockwood & Co.) 2*s.* 6*d.* net.

Maize: its History, Cultivation, Handling, and Uses. By J. Burtt-Davy, F.L.S. Pp. xl + 831. (London: Longmans, Green & Co.) 25*s*. net.

Broomhall's Corn Trade Year Book. Pp. 96. (Liverpool: The Northern Publishing Company; London: "The Corn Trade News.") 6*s*. net.

Handboek voor Cultuur- en Handelsondernemingen in Nederlandsch-Indië, 1914. Pp. x + 1655. (Amsterdam: J. H. de Bussy.) 10 florins.

A Textbook of Medical Entomology. By W. S. Patton, M.B., I.M.S., and F. W. Cragg, M.D., I.M.S., F.E.S. Pp. xxiii + 764. (London, Madras, and Calcutta: Christian Literature Society of India.) 21*s*.

The "Times" American Railway Number (English and French Editions), Shipping Number, and Textile Numbers. (London: "The Times.") 6*s*. net each.

The Way of Unity and Peace. Pp. 16. (London: Smith, Elder & Co.) 1*d*.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial, Indian, and other Governments concerned.

NYASALAND SOILS

In a previous number of this Bulletin (1912, **10**, 55), an account was given of the results of examination at the Imperial Institute of a series of soils from the chief cotton-growing areas in the Nyasaland Protectorate.

Since then two further series of Nyasaland soils have been examined, viz. thirty-one from the Lake Shirwa district, and four typical soils from tobacco estates in the Protectorate.

The soils from the Lake Shirwa district were collected by Mr. E. B. Gamlen, First Assistant Agriculturist of the Nyasaland Department of Agriculture, during a tour in this area which comprised the following itinerary: Leaving Zomba on August 15, 1912, Mr. Gamlen proceeded along the Mlanje road as far as the Namadzi stream, and then down the Palombe stream to Lake Shirwa. From thence, passing Pyupyu Hill on his right, he crossed the Naisi and Songani streams, reaching the Domasi stream near Chikala Hill, and returned from there via Msondole and the Liwonde road to Zomba. Mr. Gamlen's notes on the soils in this area are as follows:

Between Zomba and the Namiwawa stream the soil is a light clay loam; beyond this to the Ntondwe stream

it is a very fertile, deep, sandy loam. Beyond the Ntondwe to the Namadzi the soil is thin and stony, and not much cultivated. Going down the Palombe stream one finds a heavy clay soil extending almost to Lake Shirwa, where it changes in character to alluvium or gravel. Thence going in a north-westerly direction to the Likangala stream there is a hard clay with patches of sand overlying it in places. The area near Lake Shirwa is not much cultivated, as the drainage is defective owing to the presence of "hard pan" beneath the surface; but the soil immediately by the lake shore is very fertile. If this "pan" could be broken it is thought that excellent crops might be grown. North of the Likangala to Pyupyu Hill the soil is a fertile, sandy loam, that near the hill being a red clay identical with that found at Zomba, with rocks close to the surface. North of Pyupyu Hill to the Domasi stream the soil is chiefly light sand, but clay occurs near the Naisi, Songani, and Domasi streams. Returning to Zomba, deep sandy soil prevails till Msondole is reached; from thence to the Liwonde-Zomba road a clay loam occurs, and in the valley between this road and the Domasi Mission a heavy clay. Patches of very fertile soil occur near the various streams crossed on the homeward road to Zomba, and are well cultivated by the natives.

The samples collected in the Lake Shirwa District were examined with a view to ascertaining their suitability for the cultivation of cotton and tobacco. Each sample, which represented the soil and subsoil to a depth of 12 in., was submitted to (1) a mechanical analysis, performed on the entire soil, which was air-dried before examination, and (2) a chemical analysis of that portion of the soil which passed through a 1 mm. sieve. The figures giving the "available" constituents in pounds per acre were calculated in each case for a depth of 9 in., the apparent specific gravity of the soil being taken into account. The four typical tobacco soils were examined on similar lines. The descriptions applied to samples Nos. 1 to 31 are those given on the labels attached to the samples, but they do not in all cases strictly agree with the results of the mechanical analyses.

SOILS FROM THE LAKE SHIRWA DISTRICT

No. 1.—"Sandy loam, Zomba-Mlanje road."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4·20	43·06	14·03	35·95	2·17	0·06 [1]

[1] *Including chlorides equivalent to* 0·004 *per cent. chlorine* (Cl), *and sulphates equivalent to* 0·02 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·38	—	—
Magnesia	MgO	—	0·43	—	—
Potash	K_2O	—	0·19	0·018	525
Ferric oxide	Fe_2O_3	—	6·16	—	—
Phosphoric acid	P_2O_5	—	0·11	0·004	117
Nitrogen	N	0·08 [1]	—	—	—
Carbon dioxide	CO_2	0·02	—	—	—
Loss on ignition		8·43	—	—	—
Humus		0·79 [2]	—	—	—

[1] *Equivalent to* 2,450 *lb. per acre.* [2] *Containing nitrogen* 10·63 *per cent.*

This soil contains sufficient "acid-soluble" lime, potash, and phosphoric acid. There is also an adequate quantity of "available" potash, but the percentage of "available" phosphoric acid is low. The quantity of nitrogen present is below the standard required for many crops, but would probably suffice for cotton or "bright" tobacco. For cotton cultivation it would be advisable to increase the quantity of humus in the soil by "green manuring."

No. 2.—"Deep clay loam, Ulumba Hill."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
6·84	34·71	25·33	29·17	4·26	0·05[1]

[1] *Including chlorides equivalent to* 0·001 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·024 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO . .	—	1·16	—	—
Magnesia MgO . .	—	0·88	—	—
Potash K_2O . .	—	0·28	0·018	488
Ferric oxide Fe_2O_3 . .	—	9·04	—	—
Phosphoric acid P_2O_5 . .	—	0·72	0·162	4,395
Nitrogen N . . .	0·15[1]	—	—	—
Carbon dioxide CO_2 . .	0·01	—	—	—
Loss on ignition . . .	13·14	—	—	—
Humus	2·27[2]	—	—	—

[1] *Equivalent to* 4,069 *lb. per acre.* [2] *Containing nitrogen* 3·65 *per cent.*

This soil contains a sufficiency of all the constituents necessary for crops, and is noteworthy for its high percentage of phosphoric acid. The large amount of phosphoric acid and the richness in nitrogen would make this soil rather unsuitable for the cultivation of "bright" tobacco until the quantities of these constituents have been somewhat reduced by growing other crops, but otherwise the soil appears to be well suited either for "bright" tobacco or cotton.

No. 3.—"Sandy loam (clay subsoil), Government Farm, River Namiwawa."

Mechanical Analysis

Sizes of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
5·24	38·38	20·80	33·14	2·37	0·07 [1]

[1] *Including sulphates equivalent to* 0·038 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received. No chlorine was present.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·20	—	—
Magnesia	MgO	—	0·45	—	—
Potash	K_2O	—	0·08	0·021	589
Ferric oxide	Fe_2O_3	—	6·96	—	—
Phosphoric acid	P_2O_5	—	0·15	0·003	84
Nitrogen	N	0·07 [1]	—	—	—
Carbon dioxide	CO_2	0·02	—	—	—
Loss on ignition		9·31	—	—	—
Humus		0·59 [2]	—	-	—

[1] *Equivalent to* 1,907 *lb. per acre.* [2] *Containing nitrogen* 7·83 *per cent.*

This soil contains adequate supplies of "acid-soluble" lime and phosphoric acid, and of "available" potash. The percentages of nitrogen, and especially that of "available" phosphoric acid, are however low, and the amount of "acid-soluble" potash is also rather low.

For the cultivation of cotton or "bright" tobacco the proportion of "available" phosphoric acid in this soil needs to be augmented; this could be done by applying basic slag or bone meal, or a dressing of lime would serve the same purpose for a time. For the cultivation of cotton or tobacco, but especially of the former, the soil would benefit by "green manuring," as this would increase the amounts of humus and nitrogen present.

No. 4.—"Sandy loam, Zomba-Mlanje Road."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
6·14	61·06	16·87	15·06	1·40	0·08 [1]

[1] *Including sulphates equivalent to* 0·046 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received. No chlorine was present.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO . .	—	0·27	—	—
Magnesia MgO . .	—	0·34	—	—
Potash K_2O . .	—	0·22	0·012	402
Ferric oxide Fe_2O_3 . .	—	6·40	—	—
Phosphoric acid P_2O_5 . .	—	0·16	0·020	670
Nitrogen N . .	0·06 [1]	—	—	—
Carbon dioxide CO_2 . .	0·03	—	—	—
Loss on ignition . . .	5·86	—	—	—
Humus	0·85 [2]	—	—	—

[1] *Equivalent to* 2,179 *lb. per acre.* [2] *Containing nitrogen* 7·66 *per cent.*

This soil contains sufficient quantities of the mineral plant foods, but the percentage of nitrogen is low. The soil appears to be suitable for the cultivation of "bright" tobacco, but it would require "green manuring" to render it fit for growing cotton.

No. 5.—"Deep loam, Kaserema's Village, Zomba-Mlanje Road."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4·36	36·88	24·73	29·57	3·90	0·07 [1]

[1] *Including a trace of chlorine, and sulphates equivalent to* 0·015 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·36	—	—
Magnesia	MgO	—	0·34	—	—
Potash	K_2O	—	0·10	0·018	497
Ferric oxide	Fe_2O_3	—	2·80	—	—
Phosphoric acid	P_2O_5	—	0·11	0·039	1,077
Nitrogen	N	0·11[1]	—	—	—
Carbon dioxide	CO_2	0·01	—	—	—
Loss on ignition		11·15	—	—	—
Humus		1·22[2]	—	—	—

[1] *Equivalent to* 3,039 *lb. per acre.* [2] *Containing nitrogen* 6·55 *per cent.*

This soil contains a sufficient supply of all the necessary plant-food ingredients, except that the reserve of potash, as shown by the quantity soluble in hydrochloric acid, is somewhat low. The soil is suitable for the cultivation of cotton or "bright" tobacco.

No. 6.—" Loam (stony subsoil), Zomba-Mlanje Road."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14·18	56·09	16·92	10·92	2·35	0·07[1]

[1] *Including a trace of chlorine, and sulphates equivalent to* 0·005 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	1·17	—	—
Magnesia	MgO	—	0·77	—	—
Potash	K_2O	—	0·25	0·008	227
Ferric oxide	Fe_2O_3	—	5·61	—	—
Phosphoric acid	P_2O_5	—	0·31	0·109	3,100
Nitrogen	N	0·05[1]	—	—	—
Carbon dioxide	CO_2	0·02	—	—	—
Loss on ignition		6·00	—	—	—
Humus		0·82[2]	—	—	—

[1] *Equivalent to* 1,422 *lb. per acre.* [2] *Containing nitrogen* 4·87 *per cent.*

This soil contains adequate supplies of all the plant-food constituents except nitrogen. It is noteworthy for its high percentages of "acid-soluble" and "available" phosphoric acid.

From the description of the subsoil it appears probable that this soil, which is of a sandy character as a whole, would not be sufficiently retentive of moisture for the cultivation of cotton or "bright" tobacco. If these crops are tried it will be advisable to "green manure" the soil for cotton, and to apply potash, preferably in the form of wood, or plant ashes rich in this constituent, for tobacco.

No. 7.—"Deep loam, Namadzi Stream, Zomba-Mlanje Road."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0·26	49·08	37·27	11·64	2·45	0·06 [1]

[1] *Including chlorides equivalent to* 0·005 *per cent. chlorine* (Cl), *and sulphates equivalent to* 0·016 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO . .	—	0·52	—	—
Magnesia MgO . .	—	0·82	—	—
Potash K_2O . .	—	0·15	0·005	138
Ferric oxide Fe_2O_3 . .	—	4·52	—	—
Phosphoric acid P_2O_5 . .	—	0·12	0·072	1,989
Nitrogen N . .	0·10 [1]	—	—	—
Carbon dioxide CO_2 . .	0·02	—	—	—
Loss on ignition . . .	7·60	—	—	—
Humus	1·52 [2]	—	—	—

[1] *Equivalent to* 2,763 *lb. per acre.* [2] *Containing nitrogen* 3·29 *per cent.*

This soil contains a sufficient supply of plant-food constituents, but for the culture of "bright" tobacco it

would need to be supplied with potash. The soil might be tried for cotton cultivation, and it is probable that the crop would be successful if the subsoil is fairly retentive of moisture.

No. 8.—"Deep sandy loam, River Palombe, Sanji Hill."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent. 1·57	*Per cent.* 48·51	*Per cent.* 35·46	*Per cent.* 11·55	*Per cent.* 2·30	*Per cent.* 0·08 [1]

[1] *Including a trace of chlorine, and sulphates equivalent to* 0·012 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·37	—	—
Magnesia	MgO	—	0·58	—	—
Potash	K_2O	—	0·14	0·018	512
Ferric oxide	Fe_2O_3	—	4·68	—	—
Phosphoric acid	P_2O_5	—	0·07	0·013	369
Nitrogen	N	0·08 [1]	—	—	—
Carbon dioxide	CO_2	0·02	—	—	—
Loss on ignition		16·65	—	—	—
Humus		1·55 [2]	—	—	—

[1] *Equivalent to* 2,275 *lb. per acre.* [2] *Containing nitrogen* 2·59 *per cent.*

This soil contains sufficient "acid-soluble" lime, and "available" potash and phosphoric acid. The proportions of nitrogen and of "acid-soluble" potash and phosphoric acid are, however, rather below standard. The soil is suitable for growing "bright" tobacco, provided that potash is applied in a short time, and it might be used for cotton cultivation if it is underlain by a retentive subsoil.

No. 9.—"Peaty soil, plain near River Palombe."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
7·16	34·45	16·17	38·85	3·56	0·16[1]

[1] *Including chlorides equivalent to* 0·005 *per cent. chlorine* (Cl), *and sulphates equivalent to* 0·035 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	0·53	—	—
Magnesia MgO	—	0·36	—	—
Potash K_2O	—	0·11	0·007	185
Ferric oxide Fe_2O_3	—	7·29	—	—
Phosphoric acid P_2O_5	—	0·10	0·007	185
Nitrogen N	0·09[1]	—	—	—
Carbon dioxide CO_2	0·07	—	—	—
Loss on ignition	11·15	—	—	—
Humus	2·74[2]	—	—	—

[1] *Equivalent to* 2,377 *lb. per acre.* [2] *Containing nitrogen* 2·3 *per cent.*

This soil contains sufficient quantities of "acid-soluble" lime and phosphoric acid, and of "available" potash. The amounts of nitrogen, "acid-soluble" potash, and "available" phosphoric acid are, however, rather below standard. If the soil was treated with potash it would probably be suitable for the cultivation of "bright" tobacco, but for cotton growing it would benefit by the application of a phosphatic manure.

No. 10.—"Sand, near Dianyama's Village, River Palombe."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17·28	58·45	11·20	12·23	1·20	0·06[1]

[1] *Including a trace of chlorine, and sulphates equivalent to* 0·02 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·53	—	—
Magnesia	MgO	—	0·40	—	—
Potash	K_2O	—	0·17	0·016	471
Ferric oxide	Fe_2O_3	—	5·27	—	—
Phosphoric acid	P_2O_5	—	0·11	0·014	412
Nitrogen	N	0·05[1]	—	—	—
Carbon dioxide	CO_2	0·04	—	—	—
Loss on ignition		5·60	—	—	—
Humus		0·71[2]	—	—	—

[1] *Equivalent to* 1,473 *lb. per acre.* [2] *Containing nitrogen* 6·3 *per cent.*

This soil contains sufficient supplies of mineral plant-food constituents, but the proportion of nitrogen is low. The soil appears to be suitable for the cultivation of cotton or "bright" tobacco, provided that the subsoil is sufficiently retentive of moisture. For cotton growing it would need "green manuring."

No. 11.—"Deep loam (clay subsoil), River Palombe."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
7·00	42·43	14·41	32·68	3·41	0·13[1]

[1] *Including chlorides equivalent to* 0·005 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·028 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·35	—	—
Magnesia	MgO	—	0·41	—	—
Potash	K_2O	—	0·08	0·016	409
Ferric oxide	Fe_2O_3	—	7·70	—	—
Phosphoric acid	P_2O_5	—	0·07	0·008	205
Nitrogen	N	0·07[1]	—	—	—
Carbon dioxide	CO_2	0·04	—	—	—
Loss on ignition		10·69	—	—	—
Humus		0·98[2]	—	—	—

[1] *Equivalent to* 1,792 *lb. per acre.* [2] *Containing nitrogen* 6·1 *per cent.*

This soil contains adequate supplies of "acid-soluble" lime and "available" potash, but the quantities of the other plant-food constituents are below standard. For the growing of "bright" tobacco it would probably suffice if potash were applied to the soil, but for cotton cultivation it would be necessary to apply a phosphatic manure, and to adopt a course of "green manuring."

No. 12.—"Clay, Chitungas, River Palombe."

Mechanical Analysis

Size of particles in millimetres.				Moisture. at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0·38	37·30	21·25	36·83	4·81	0·11 [1]

[1] *Including chlorides equivalent to* 0·005 *per cent. chlorine* (Cl), *and sulphates equivalent to* 0·022 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·82	—	—
Magnesia	MgO	—	0·94	—	—
Potash	K_2O	—	0·26	0·016	390
Ferric oxide	Fe_2O_3	—	9·36	—	—
Phosphoric acid	P_2O_5	—	0·46	0·041	999
Nitrogen	N	0·13 [1]	—	—	—
Carbon dioxide	CO_2	0·06	—	—	—
Loss on ignition		15·49	—	—	—
Humus		2·58 [2]	—	—	—

[1] *Equivalent to* 3,170 *lb. per acre.*

[2] *Containing nitrogen* 3·1 *per cent.*

This soil contains adequate amounts of all the necessary plant-food constituents, and appears to be suitable for cotton cultivation. For the growing of "bright" tobacco it is rather "heavy," and would need the application of potash in order to increase the "available" supply of this constituent.

No. 13.—"Clay, near Chimombo's Village, River Palombe."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1·51	13·52	44·30	35·50	5·33	0·12 [1]

[1] *Including chlorides equivalent to* 0·005 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·023 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·64	—	—
Magnesia	MgO	—	0·70	—	—
Potash	K_2O	—	0·18	0·013	343
Ferric oxide	Fe_2O_3	—	4·56	—	—
Phosphoric acid	P_2O_5	—	0·39	0·075	1,981
Nitrogen	N	0·09 [1]	—	—	—
Carbon dioxide	CO_2	0·06	—	—	—
Loss on ignition		13·45	—	—	—
Humus		2·05 [2]	—	—	—

[1] *Equivalent to* 2,377 *lb. per acre.* [2] *Containing nitrogen* 3·2 *per cent.*

This soil contains adequate quantities of mineral plant-food constituents, but the percentage of nitrogen is slightly below standard. The soil is suitable for cotton cultivation, but it is rather "heavy" for "bright" tobacco, and if the latter crop were tried it would be advisable to apply potash.

No. 14.—"Alluvial, near Lake Shirwa, River Palombe."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12·40	34·49	23·02	26·56	3·80	0·16 [1]

[1] *Including chlorides equivalent to* 0·005 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·031 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	0·40	—	—
Magnesia MgO	—	1·11	—	—
Potash K_2O	—	0·14	0·018	508
Ferric oxide Fe_2O_3	—	4·88	—	—
Phosphoric acid P_2O_5	—	0·17	0·029	819
Nitrogen N	0·07 [1]	—	—	—
Carbon dioxide CO_2	0·06	—	—	—
Loss on ignition	8·97	—	—	—
Humus	1·01 [2]	—	—	—

[1] *Equivalent to* 1,977 *lb. per acre.* [2] *Containing nitrogen* 5·1 *per cent.*

The soil contains adequate amounts of plant-food constituents except in the case of nitrogen. It appears to be suitable for the cultivation of either "bright" tobacco or cotton, but for the latter crop "green manuring" would probably be advisable. The soil, however, may prove unsuitable for either of these crops, as the area near Lake Shirwa is badly drained on account of underlying "hard pan" (see p. 180).

No. 15.—"Sand, Lake Shirwa, River Palombe."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
34·61	63·41	1·08	0·87	0·17	0·08 [1]

[1] *Including chlorides equivalent to* 0·001 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·009 *per cent. sulphuric acid* (*SO_3*), *expressed on the sample as received.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	0·13	—	—
Magnesia MgO	—	0·08	—	—
Potash K_2O	—	0·01	0·006	190
Ferric oxide Fe_2O_3	—	0·85	—	—
Phosphoric acid P_2O_5	—	0·04	0·019	602
Nitrogen N	0·03 [1]	—	—	—
Carbon dioxide CO_2	0·02	—	—	—
Loss on ignition	1·42	—	—	—
Humus	0·30 [2]	—	—	—

[1] *Equivalent to* 951 *lb. per acre.* [2] *Containing nitrogen* 4·3 *per cent.*

This soil is deficient in "acid-soluble" lime, phosphoric acid, and potash, and also in nitrogen. The "available" phosphoric acid is sufficient, but the "available" potash is rather low. The soil is too poor and sandy for the satisfactory cultivation of tobacco or cotton, and, as in the case of the preceding soil, it may also suffer from "hard pan" in the subsoil.

No. 16.—"Alluvial soil by Lake Shirwa, River Palombe."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	0·35	6·40	84·84	8·35	0·06[1]

[1] *Including chlorides equivalent to* 0·01 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·01 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	1·00	—	—
Magnesia MgO	—	1·25	—	—
Potash K_2O	—	0·39	0·021	529
Ferric oxide Fe_2O_3	—	9·12	—	—
Phosphoric acid P_2O_5	—	0·34	0·073	1,839
Nitrogen N	0·24[1]	—	—	—
Carbon dioxide CO_2	0·08	—	—	—
Loss on ignition	23·24	—	—	—
Humus	2·60[2]	—	—	—

[1] *Equivalent to* 6,046 *lb. per acre.* [2] *Containing nitrogen* 5·65 *per cent.*

This soil contains a good supply of all the necessary plant-food constituents, but it is too clayey for the successful cultivation of cotton or "bright" tobacco.

No. 17.—"Deep clay soil, Makawa Village, Likangala River."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	8·85	13·80	69·09	8·17	0·09 [1]

[1] *Including chlorides equivalent to* 0·01 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·02 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	0·55	—	—
Magnesia MgO	—	0·61	—	—
Potash K_2O	—	0·23	0·024	610
Ferric oxide Fe_2O_3	—	7·20	—	—
Phosphoric acid P_2O_5	—	0·21	0·047	1,194
Nitrogen N	0·20 [1]	—	—	—
Carbon dioxide CO_2	0·02	—	—	—
Loss on ignition	22·14	—	—	—
Humus	2·38 [2]	—	—	—

[1] *Equivalent to* 5,080 *lb. per acre.* [2] *Containing nitrogen* 4·94 *per cent.*

This soil contains a good supply of the necessary plant-food constituents, but is probably of too "heavy" a character for the cultivation of cotton or "bright" tobacco.

No. 18.—"Sand (clay subsoil), Makawa Village, Likangala River."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	57·35	16·90	23·16	2·56	0·03 [1]

[1] *Including chlorides equivalent to* 0·002 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·01 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·31	—	—
Magnesia	MgO	—	0·44	—	—
Potash	K_2O	—	0·15	0·011	304
Ferric oxide	Fe_2O_3	—	3·92	—	—
Phosphoric acid	P_2O_5	—	0·14	0·040	1,105
Nitrogen	N	0·09 [1]	—	—	—
Carbon dioxide	CO_2	0·05	—	—	—
Loss on ignition		7·42	—	—	—
Humus		1·21 [2]	—	—	—

[1] *Equivalent to* 2,487 *lb. per acre.* [2] *Containing nitrogen* 4·45 *per cent.*

This soil contains adequate quantities of the necessary mineral plant-food constituents, but the amount of nitrogen is slightly below standard. The soil appears to be suitable for the cultivation of "bright" tobacco if manured with potash, and it would also be suitable for cotton cultivation if the drainage is satisfactory.

No. 19.—"Sandy loam, Mbalu Village, near Pyupyu Mountain."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	47·00	33·70	16·80	2·19	0·01 [1]

[1] *Including a trace of sulphuric acid, but no chlorine.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·42	—	—
Magnesia	MgO	—	0·36	—	—
Potash	K_2O	—	0·13	0·012	317
Ferric oxide	Fe_2O_3	—	4·16	—	—
Phosphoric acid	P_2O_5	—	0·18	0·100	2,462
Nitrogen	N	0·09 [1]	—	—	—
Carbon dioxide	CO_2	0·01	—	—	—
Loss on ignition		6·87	—	—	—
Humus		1·31 [2]	—	—	—

[1] *Equivalent to* 2,377 *lb. per acre.* [2] *Containing nitrogen* 4·27 *per cent.*

This soil closely resembles the preceding sample, No. 18, and the same remarks and recommendations apply to both samples.

No. 20.—"Sandy loam (sandy subsoil), Hasambwe Village, Mount Pyupyu."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	73·05	11·25	14·05	1·20	0·05 [1]

[1] *Including sulphates equivalent to* 0·01 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received. No chlorine was present.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	0·16	—	—
Magnesia MgO	—	0·22	—	—
Potash K_2O	—	0·11	0·007	213
Ferric oxide Fe_2O_3	—	2·35	—	—
Phosphoric acid P_2O_5	—	0·13	0·036	1,097
Nitrogen N	0·05 [1]	—	—	—
Carbon dioxide CO_2	0·02	—	—	—
Loss on ignition	5·20	—	—	—
Humus	0·70 [2]	—	—	—

[1] *Equivalent to* 1,569 *lb. per acre.* [2] *Containing nitrogen* 5·4 *per cent.*

This soil contains adequate quantities of "acid-soluble" and "available" potash and phosphoric acid, but is deficient in nitrogen, and rather low in lime. For cotton cultivation the soil is rather sandy, and in view of the sandy nature of the subsoil it may perhaps not be sufficiently retentive of moisture to satisfy the requirements of the cotton plants, although in other respects it appears quite suitable for this crop. The culture of "bright" tobacco would necessitate the application of potash, and the subsoil would probably be unsuitable for this crop.

No. 21.—"Light clay loam, Palawe Village, Mount Pyupyu."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent. 14·80	*Per cent.* 44·80	*Per cent.* 28·64	*Per cent.* 10·04	*Per cent.* 1·30	*Per cent.* 0·06 [1]

[1] *Including chlorides equivalent to* 0·005 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·02 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	0·24	—	—
Magnesia MgO	—	0·15	—	—
Potash K_2O	—	0·18	0·018	512
Ferric oxide Fe_2O_3	—	6·00	—	—
Phosphoric acid P_2O_5	—	0·12	0·033	944
Nitrogen N	0·057 [1]	—	—	—
Carbon dioxide CO_2	0·02	—	—	—
Loss on ignition	6·00	—	—	—
Humus	0·45 [2]	—	—	—

[1] *Equivalent to* 1,621 *lb. per acre.* [2] *Containing nitrogen* 8·4 *per cent.*

This soil contains adequate supplies of most of the plant-food ingredients, but is rather low in lime, and deficient in nitrogen. It would probably be suitable for either cotton or "bright" tobacco, provided that the subsoil is sufficiently retentive of moisture.

No. 22.—"Sandy loam (clay subsoil), Palawe village, Mount Pyupyu."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent. 7·60	*Per cent.* 56·24	*Per cent.* 20·00	*Per cent.* 14·60	*Per cent.* 1·58	*Per cent.* 0·11 [1]

[1] *Including a trace of chlorine, and sulphates equivalent to* 0·01 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	0·27	—	—
Magnesia MgO	—	0·31	—	—
Potash K_2O	—	0·19	0·011	313
Ferric oxide Fe_2O_3	—	4·27	—	—
Phosphoric acid P_2O_5	—	0·03	0·009	256
Nitrogen N	0·098[1]	—	—	—
Carbon dioxide CO_2	0·01	—	—	—
Loss on ignition	5·38	—	—	—
Humus	1·52[2]	—	—	—

[1] *Equivalent to* 2,792 *lb. per acre.* [2] *Containing nitrogen* 4·6 *per cent.*

This soil is deficient in "acid-soluble" and "available" phosphoric acid. For "bright" tobacco culture it would benefit by the application of potash, and for cotton cultivation "green manuring" would be advisable in order to increase the quantity of organic matter in the soil.

No. 23.—"Clay, River Naisi, Kanda's Village."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
2·80	41·48	25·12	26·68	2·84	0·10[1]

[1] *Including a minute trace of chlorine, and sulphates equivalent to* 0·02 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	0·47	—	—
Magnesia MgO	—	0·53	—	—
Potash K_2O	—	0·20	0·015	396
Ferric oxide Fe_2O_3	—	3·53	—	—
Phosphoric acid P_2O_5	—	0·32	0·093	2,457
Nitrogen N	0·128[1]	—	—	—
Carbon dioxide CO_2	0·01	—	—	—
Loss on ignition	9·42	—	—	—
Humus	3·2[2]	—	—	—

[1] *Equivalent to* 3,381 *lb. per acre.* [2] *Containing nitrogen* 2·1 *per cent.*

This soil contains adequate quantities of plant-food constituents. It would be suitable for the cultivation of "bright" tobacco or cotton, but for the former crop it would be advisable to apply potash.

No. 24.—"Sand, Ndala Stream, between Rivers Naisi and Songani."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
9·50	78·75	10·45	0·95	0·37	0·01 [1]

[1] *Including a trace of chlorine, and sulphates equivalent to* 0·004 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·12	—	—
Magnesia	MgO	—	0·38	—	—
Potash	K_2O	—	0·03	0·009	310
Ferric oxide	Fe_2O_3	—	1·60	—	—
Phosphoric acid	P_2O_5	—	0·10	0·031	1,069
Nitrogen	N	0·03 [1]	—	—	—
Carbon dioxide	CO_2	0·08	—	—	—
Loss on ignition		1·66	—	—	—
Humus		0·23 [2]	—	—	—

[1] *Equivalent to* 1,035 *lb. per acre.* [2] *Containing nitrogen* 8·69 *per cent.*

The quantities of "acid-soluble" potash, lime, and total nitrogen in this soil are low, but the "available" potash and phosphoric acid are satisfactory. The soil appears to be too sandy for the cultivation of tobacco or cotton.

No. 25.—"Loam (clay subsoil), River Songani, Banongwe Village."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0·63	33·45	30·33	31·73	3·50	0·05 [1]

[1] *Including chlorides equivalent to* 0·006 *per cent. chlorine* (*Cl*) *and sulphates equivalent to* 0·014 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO . .	—	0·36	—	—
Magnesia MgO . .	—	0·51	—	—
Potash K_2O . .	—	0·24	0·012	317
Ferric oxide Fe_2O_3 . .	—	5·96	—	—
Phosphoric acid P_2O_5 . .	—	0·11	0·047	1,241
Nitrogen N . . .	0·11 [1]	—	—	—
Carbon dioxide CO_2 . .	0·04	—	—	—
Loss on ignition . . .	10·88	—	—	—
Humus	2·07 [2]	—	—	—

[1] *Equivalent to* 2,905 *lb. per acre.* [2] *Containing nitrogen* 3·38 *per cent.*

This soil contains adequate quantities of plant-food ingredients. It appears to be suitable for cotton growing, but would probably require the addition of potash for the successful cultivation of "bright" tobacco.

No. 26.—"Clay loam (sandy subsoil), River Domasi, Nkombe Village."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13·25	41·21	22·90	20·11	1·94	0·04 [1]

[1] *Including sulphates equivalent to* 0·02 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received. No chlorine was present.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO . .	—	0·19	—	—
Magnesia MgO . .	—	0·35	—	—
Potash K_2O . .	—	0·16	0·013	388
Ferric oxide Fe_2O_3 . .	—	3·60	—	—
Phosphoric acid P_2O_5 . .	—	0·21	0·073	2,180
Nitrogen N . . .	0·09 [1]	—	—	—
Carbon dioxide CO_2 . .	0·07	—	—	—
Loss on ignition . . .	6·79	—	—	—
Humus	1·31 [2]	—	—	—

[1] *Equivalent to* 2,688 *lb. per acre.* [2] *Containing nitrogen* 3·89 *per cent.*

The soil contains satisfactory amounts of plant-food constituents, except perhaps in the case of the nitrogen and lime, which are slightly low. In view of the sandy subsoil it is possible that the land will not prove very suitable for the cultivation of cotton or "bright" tobacco, but much will depend on the depth of the top-soil.

No. 27.—"Light sandy loam near River Domasi."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14·50	67·12	9·92	6·80	1·13	0·02 [1]

[1] *Including sulphates equivalent to* 0·01 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received. No chlorine was present.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·04	—	—
Magnesia	MgO	—	0·11	—	—
Potash	K_2O	—	0·04	0·005	178
Ferric oxide	Fe_2O_3	—	2·32	—	—
Phosphoric acid	P_2O_5	—	0·02	0·017	608
Nitrogen	N	0·08 [1]	—	—	—
Carbon dioxide	CO_2	0·10	—	—	—
Loss on ignition		4·74	—	—	—
Humus		1·08 [2]	—	—	—

[1] *Equivalent to* 2,861 *lb. per acre.* [2] *Containing nitrogen* 4·63 *per cent.*

This soil contains sufficient "available" potash, and a satisfactory amount of "available" phosphoric acid, but it shows a deficiency in "acid-soluble" potash, phosphoric acid, and lime. The amount of total nitrogen is slightly low. The soil is rather sandy, but it would probably be suitable for either "bright" tobacco or cotton if the subsoil is sufficiently retentive of moisture.

No. 28.—"Deep sandy loam, River Songani, near Msondole Village."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0·55	55·75	22·03	18·56	2·68	0·05 [1]

[1] *Including a trace of chlorine, and sulphates equivalent to* 0·02 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·42	—	—
Magnesia	MgO	—	0·64	—	—
Potash	K_2O	—	0·32	0·032	806
Ferric oxide	Fe_2O_3	—	5·44	—	—
Phosphoric acid	P_2O_5	—	0·19	0·061	1,537
Nitrogen	N	0·13 [1]	—	—	—
Carbon dioxide	CO_2	0·05	—	—	—
Loss on ignition		8·08	—	—	—
Humus		1·37 [2]	—	—	—

[1] *Equivalent to* 3,276 *lb. per acre.* [2] *Containing nitrogen* 4·00 *per cent.*

This soil contains adequate quantities of plant-food ingredients, and would probably be suitable for cotton or "bright" tobacco provided that the subsoil is sufficiently retentive of moisture.

No. 29.—"Clay loam, near Msondole, Zomba-Liwonde Road."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
16·84	54·60	15·01	11·32	1·59	0·05 [1]

[1] *Including sulphates equal to* 0·02 *per cent. sulphuric acid* (SO_3). *No chlorine was present.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·34	—	—
Magnesia	MgO	—	0·30	—	—
Potash	K_2O	—	0·06	0·013	409
Ferric oxide	Fe_2O_3	—	3·20	—	—
Phosphoric acid	P_2O_5	—	0·11	0·037	1,165
Nitrogen	N	0·07 [1]	—	—	—
Carbon dioxide	CO_2	0·08	—	—	—
Loss on ignition		4·90	—	—	—
Humus		1·25 [2]	—	—	—

[1] *Equivalent to* 2,204 *lb. per acre.* [2] *Containing nitrogen* 3·44 *per cent.*

The "acid-soluble" potash in this soil is low, and the "acid-soluble" phosphoric acid is rather low, as is also the nitrogen. The soil is rather sandy, but it would probably be suitable for growing either cotton or "bright" tobacco if the subsoil is sufficiently retentive of moisture.

No. 30.—"Stiff clay, valley near Domasi Mission.'

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
6·56	49·20	17·87	24·66	1·62	0·14 [1]

[1] *Including chlorides equivalent to* 0·005 *per cent. chlorine (Cl), and sulphates equivalent to* 0·034 *per cent. sulphuric acid (SO_3), expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·15	—	—
Magnesia	MgO	—	0·40	—	—
Potash	K_2O	—	0·08	0·010	285
Ferric oxide	Fe_2O_3	—	4·91	—	—
Phosphoric acid	P_2O_5	—	0·09	0·003	85
Nitrogen	N	0·05 [1]	—	—	—
Carbon dioxide	CO_2	0·05	—	—	—
Loss on ignition		7·56	—	—	—
Humus		0·67 [2]	—	—	—

[1] *Equivalent to* 1,422 *lb. per acre.* [2] *Containing nitrogen* 5·9 *per cent.*

The amounts of "acid-soluble" potash, "available" and "acid-soluble" phosphoric acid, and nitrogen in this soil are low; the lime is also rather low. The soil could be used for cotton growing if the humus and nitrogen were augmented by "green manuring," and a dressing of some phosphatic manure were applied. For growing "bright" tobacco the soil would also need the application of potash.

No. 31.—"Deep loam (sandy subsoil), Naisi Stream, Zomba-Liwonde Road."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4·77	62·34	17·72	14·03	1·36	0·16[1]

[1] *Including chlorides equivalent to* 0·009 *per cent. chlorine* (Cl), *and sulphates equivalent to* 0·050 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·19	—	—
Magnesia	MgO	—	0·52	—	—
Potash	K_2O	—	0·14	0·013	343
Ferric oxide	Fe_2O_3	—	5·01	—	—
Phosphoric acid	P_2O_5	—	0·24	0·034	898
Nitrogen	N	0·10[1]	—	—	—
Carbon dioxide	CO_2	0·02	—	—	—
Loss on ignition		7·06	—	—	—
Humus		1·27[2]	—	—	—

[1] *Equivalent to* 2,642 *lb. per acre.* [2] *Containing nitrogen* 4·1 *per cent.*

This sample contains sufficient supplies of plant-food constituents. The soil is however rather sandy, and in view of the sandy character of the subsoil it may not perhaps be sufficiently retentive of moisture to satisfy the requirements of cotton and "bright" tobacco, although in other respects it appears quite suitable for these crops.

SOILS FROM TOBACCO ESTATES

No. 32.—Chiranga Estate, Nyasaland. A brown loamy soil.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4·47	42·04	22·70	28·82	2·45	0·09 [1]

[1] *Including chlorides equivalent to* 0·010 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·015 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	0·40	—	—
Magnesia MgO	—	0·22	—	—
Potash K_2O	—	0·14	0·030	852
Ferric oxide Fe_2O_3	—	6·88	—	—
Phosphoric acid P_2O_5	—	0·14	0·025	710
Nitrogen N	0·15 [1]	—	—	—
Carbon dioxide CO_2	0·02	—	—	—
Loss on ignition	10·75	—	—	—
Humus	1·72 [2]	—	—	—

[1] *Equivalent to* 4,260 *lb. per acre.* [2] *Containing nitrogen* 5·23 *per cent.*

This soil contains adequate quantities of the necessary plant-food constituents, but the reserve of potash is rather low and precautions should be taken to conserve it as much as possible.

No. 33.—Ntondwe Estate, Nyasaland. A brown loam.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11·64	38·74	16·48	30·71	2·37	0·06 [1]

[1] *Including chlorides equivalent to* 0·006 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·01 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	0·10	—	—
Magnesia MgO	—	0·13	—	—
Potash K_2O	—	0·15	0·011	320
Ferric oxide Fe_2O_3	—	6·60	—	—
Phosphoric acid P_2O_5	—	0·04	0·021	610
Nitrogen N	0·10 [1]	—	—	—
Carbon dioxide CO_2	0·05	—	—	—
Loss on ignition	9·46	—	—	—
Humus	0·86 [2]	—	—	—

[1] *Equivalent to* 2,906 *lb. per acre.* [2] *Containing nitrogen* 5·93 *per cent.*

This soil is somewhat deficient in reserves of lime and "acid-soluble" phosphoric acid, and manures containing these constituents should be supplied shortly. In cultivation every precaution should be taken to conserve the potash, and if the tobacco grown on this soil shows any defect in burning quality, the soil should be manured with wood ashes or some similar product rich in potash.

No. 34.—Naisi Estate, Nyasaland. A brown loam.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
2·06	46·72	19·20	29·63	2·37	0·02 [1]

[1] *Including traces of chlorides and sulphates.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	0·29	—	—
Magnesia MgO	—	0·48	—	—
Potash K_2O	—	0·34	0·016	475
Ferric oxide Fe_2O_3	—	6·68	—	—
Phosphoric acid P_2O_5	—	0·10	0·016	475
Nitrogen N	0·09 [1]	—	—	—
Carbon dioxide CO_2	0·05	—	—	—
Loss on ignition	8·80	—	—	—
Humus	0·96 [2]	—	—	—

[1] *Equivalent to* 2,670 *lb. per acre.* [2] *Containing nitrogen* 5·00 *per cent.*

This soil contains a sufficiency of plant food constituents, but for crops other than tobacco it would benefit by "green manuring."

No. 35.—Mlungusi Estate, Nyasaland. A dark brown loam.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11·85	36·02	28·95	19·52	3·81	0·16

[1] *Including a trace of chlorides, and sulphates equivalent to* 0·021 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	0·77	—	—
Magnesia MgO	—	0·67	—	—
Potash K_2O	—	0·20	0·021	504
Ferric oxide Fe_2O_3	—	6·95	—	—
Phosphoric acid P_2O_5	—	0·43	0·055	1,319
Nitrogen N	0·32 [1]	—	—	—
Carbon dioxide CO_2	0·06	—	—	—
Loss on ignition	16·03	—	—	—
Humus	4·71 [2]	—	—	—

[1] *Equivalent to* 7,674 *lb. per acre.* [2] *Containing nitrogen* 3·47 *per cent.*

This soil contains a sufficiency of plant-food constituents. The percentage of nitrogen is however very high for a satisfactory soil for "bright" tobacco, and it would probably improve the soil for this crop if one or two crops of maize or other similar product were taken off it.

General Remarks

In making suggestions as to the suitability of the various soils for cotton and "bright" tobacco it has been assumed that the climatic and other conditions are suitable for these crops. Further, in making these sug-

gestions, comparisons have been made with the results of analyses of cotton soils from Nyasaland previously examined at the Imperial Institute, and with the four tobacco soils on which reports are now furnished (*Nos.* 32 to 35), rather than with the soils on which cotton and "bright" tobacco are grown in the United States and elsewhere.

PENGUIN GUANO FROM THE FALKLAND ISLANDS

The five samples of penguin guano from the Falkland Islands which are the subject of this report were received in October 1913.

It was stated that the samples had been obtained from Cochon and Kidney Islands, and it was desired to ascertain their commercial value and the best method of preparing the guano for export.

The samples were as follows:

Nos. 1, 2, *and* 3. *From Cochon Island.*—These consisted of black, wet, slimy masses, containing much organic matter together with some fibrous material. A few small bones of birds and a small quantity of sand were also present.

Nos. 4 *and* 5. *From Kidney Island.*—These were similar to those from Cochon Island, but No. 4 contained, in addition to the constituents mentioned above, about 7 per cent. of fine gravel.

The samples were submitted to preliminary examination at the Imperial Institute with the following results:

	From Cochon Island.			From Kidney Island.	
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture, on drying at 105° C.	72·93	75·62	74·06	63·69	80·07
Additional loss on ignition	15·69	15·24	13·71	21·73	12·13
Ash	11·38	9·14	12·23	14·58	7·80

Chemical analyses of the samples as received at the Imperial Institute showed them to contain the following proportions of manurial and other constituents:

		From Cochon Island.			From Kidney Island.	
		No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Lime	CaO	3·74	2·92	1·26	1·52	2·46
Magnesia	MgO	0·72	0·17	0·10	0·33	0·41
Potash	K_2O	0·19	0·16	0·32	0·21	0·20
Soda	Na_2O	0·35	0·32	0·31	0·26	0·32
Sulphuric acid	SO_3	0·09	0·14	0·10	0·21	0·08
Chlorine	Cl	0·20	0·38	0·36	0·17	0·27
Phosphoric acid	P_2O_5	4·22	3·48	1·22	1·55	2·66
Consisting of:						
Portion soluble in 2 per cent. citric acid solution[1]		4·08[1]	3·28[1]	1·11[1]	1·24[1]	2·32[1]
Portion insoluble in 2 per cent. citric acid solution		0·14	0·20	0·11	0·31	0·34
Nitrogen	N	1·71	1·23	0·96	1·23	1·02
Consisting of:						
Portion present in organic form		1·17	0·78	0·61	1·00	0·70
,, ,, as ammonium salts		0·49	0·25	0·27	0·03	0·21
Portion present as nitrates		0·05	0·20	0·08	0·20	0·11
[1] Including phosphoric acid (P_2O_5) soluble in water		1·02	0·30	0·50	0·80	0·63

The commercial value of these samples in the United Kingdom, based on the average current values per unit per cent. for the constituents nitrogen, phosphoric acid, and potash, would be approximately as follows (March 1914):

Sample.	Value per ton c.i.f. United Kingdom ports.
No. 1	32*s.*
No. 2	24*s.*
No. 3	17*s.*
No. 4	21*s.*
No. 5	20*s.*

It is evident that, at the prices quoted above, it would not be remunerative to export guanos of the composition of the present samples to any considerable distance. The results of the analyses show, however, that the samples contained an excessive quantity of water, varying from 64 to 80 per cent.; and if this could be reduced to say 20 per cent. these materials from Cochon and Kidney Islands would be comparable with certain commercial guanos.

The following table shows the results of re-calculating the amounts of the valuable constituents of these guanos,

assuming the amount of moisture present to have been reduced to 20 per cent. Analyses recorded by Fritsch for another sample from the Falkland Islands, and for three samples of Peruvian guano are added for comparison:

	Moisture. H_2O.	Nitrogen. N.	Potash. K_2O.	Phosphoric acid. P_2O_5.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Cochon Island, No. 1	20·0	5·05	0·56	12·45
,, ,, ,, 2	20·0	4·03	0·53	11·42
,, ,, ,, 3	20·0	3·17	0·98	3·72
Kidney Island, No. 4	20·0	2·71	0·46	3·41
,, ,, ,, 5	20·0	4·08	0·80	10·64
Sample from the Falkland Islands, as recorded by Fritsch	8·86	1·24	—	9·75
Samples from Peru:				
Lobos de Afuera Island	19·60	3·60	2·50	16·70
Guanape Island	25·88	11·00	2·50	12·25
Ballestas Island	14·87	12·50	2·50	12·23

It will be seen from these figures that as compared with good Peruvian guano the present samples from the Falkland Islands contained much less nitrogen and potash, and the percentage of phosphoric acid is also much lower in the case of samples 3 and 4. Samples 1, 2, and 5 are better as regards nitrogen and phosphoric acid than the guano from the Falkland Islands previously examined (No. 6 in table).

It is possible that the present samples are from the top layers of the deposits and may have been exposed to rain; in that case the guano situated at a short distance below the surface will probably prove to be richer in manurial constituents than these samples.

The Peruvian guanos of commerce, being obtained from a very dry region, are not specially dried before export, but if it is desired to prepare material similar to the present samples from the Falkland Islands for export the percentage of water should be reduced, in order to minimise freight charges and to render the guano easier to handle. On exposure to the air for six days it was found that sample No. 5 lost 70 per cent. of moisture, thus showing that under suitable conditions simple air-drying would suffice for the purpose.

FLAX FROM THE EAST AFRICA PROTECTORATE

THE cultivation of the flax plant for the production of seed has been conducted on an experimental scale for some years past in various parts of the East Africa Protectorate, and it is thought that there is every prospect of its cultivation becoming in a short time thoroughly established throughout a large portion of the Nyanza Province.

The cultivation of the plant for the production of fibre should be possible in the Highland districts of the Protectorate. A sample of flax fibre which had been prepared from the stems of plants grown for seed in the Limoru district was examined at the Imperial Institute some years ago (see this BULLETIN, 1911, **9**, 11), as well as fibre prepared from plants grown at the Government Experimental Farm, Kabete (*loc. cit.*, p. 13). Both these specimens had apparently been imperfectly retted, and their value was consequently low. Four further samples of fibre produced at Kabete were received for examination recently. They were as follows:

No. 1.—This sample, which was received in October 1913, consisted of flax which had been retted, broken, and scutched. It was of rather dark brownish-grey colour, soft and lustrous, and well cleaned and prepared, being practically free from "shieve." It was of good strength, and varied in length from 2 ft. 10 in. to 3 ft. 3 in., but was mostly about 3 ft.

It was examined with the following results compared with standard samples of Russian and Belgian flax:

	Present sample. *Per cent.*	Standard Russian flax. *Per cent.*	Standard Belgian flax. *Per cent.*
Moisture	7·9	8·4	8·7
Ash	1·0	0·9	0·9
α-Hydrolysis, loss	14·4	12·7	11·0
β-Hydrolysis, loss	22·0	21·1	19·2
Acid purification, loss	4·7	5·2	3·9
Cellulose	82·5	83·4	84·5

The length of the ultimate fibres ranged from 0·5 to 2·9 in., with an average of 1·6 in., and their diameter varied from 0·0004 to 0·001 in., with an average of 0·0007 in.

The fibre was regarded by experts as worth £50 per ton (December 1913).

The above results indicate that this flax was of good quality, and that it closely resembled the standard European varieties in chemical composition and behaviour. The experts to whom the fibre was submitted for valuation stated that it should be of great interest to the spinning trade of the United Kingdom, which imports from Russia and other parts of Europe about 90,000 tons of flax annually.

The following three samples were received in January of this year. In each case the flax had been retted, broken, and scutched.

No. 2.—"Fibre obtained from straw not laid by rain." This sample consisted of lustrous, fairly soft fibre, well cleaned and prepared, and almost free from "shieve." The colour was slightly irregular, varying from a light brownish-grey to a somewhat darker brownish- or greenish-grey. The strength of the fibre was rather irregular, but on the whole was good. Its length varied from about 2 ft. to 3 ft. 4 in., but was mostly about 2 ft. 9 in.

No. 3.—"Fibre obtained from straw not badly laid by rain." This sample was soft and lustrous, fairly well cleaned and prepared, and contained only a small quantity of "shieve." It was darker than No. 2, the colour being dark brownish- or greenish-grey. The fibre was of irregular strength, the greater part being good, whilst that of some portions was poor. It varied in length from about 2 ft. to 3 ft. 4 in., but was mostly about 2 ft. 8 in.

No. 4.—"Fibre obtained from straw badly laid by rain." This sample was slightly harsh, moderately lustrous, and fairly well cleaned and prepared, containing only a very small proportion of "shieve." The colour was dark brownish- or greenish-grey, similar to that of sample No. 3. The strength of the fibre was irregular and on the whole rather poor. The length ranged from about 18 in. to 2 ft. 11 in., but was mostly about 2 ft. 2 in. A good deal of short towy fibre was also present.

Samples 2, 3, and 4 were examined with the following results, compared with those afforded by a standard sample of Belgian flax:

	No. 2.	No. 3.	No. 4.	Standard Belgian flax.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	9·3	9·3	8·0	8·7
Ash	1·1	1·0	1·2	0·9
α-Hydrolysis, loss	9·4	11·4	10·7	11·0
β-Hydrolysis, loss	18·3	18·7	18·9	19·2
Acid purification, loss	2·2	3·0	2·8	3·9
Cellulose	85·0	82·5	83·6	84·5
Length of ultimate fibres	from about 0·2 in. to 3·4 in.	from about 0·2 in. to 2·7 in.	from about 0·2 in. to 3·3 in.	—
Diameter of ultimate fibres	0·0003 in. to 0·0010 in.; average 0·00057 in.	0·0003 in. to 0·0009 in.; average 0·00060 in.	0·0004 in. to 0·0014 in.; average 0·00066 in.	—

Sample No. 2 was of very satisfactory quality, although somewhat dark in colour; it was valued at £56 per ton. No. 3 was of good quality and was valued at £48 to £50 per ton, but its value was reduced by its dark colour and uneven strength. No. 4 was valued at £40 per ton, its value being reduced by its weak and rather towy nature and by its dark colour.

In chemical composition and behaviour, these three samples of flax (Nos. 2, 3, and 4) closely resembled a standard specimen of Belgian flax with which they were compared, and the ultimate fibres were of about the usual length and diameter for flax fibre.

The fibre merchants in London who valued the samples reported very favourably on them, particularly No. 2, which they stated would be saleable in any quantity in the United Kingdom. They described Nos. 3 and 4 as flaxes of good medium quality, for which they could readily find a good market at about the prices quoted in the present report. They regarded all the samples as superior to Russian flaxes and more comparable with the Belgian kinds.

COCOA FROM THE SOUTHERN PROVINCES, NIGERIA

Cocoa is grown on a considerable scale in the Southern Provinces, Nigeria, and large quantities have been exported in recent years, as is shown in the following table :

	1910.	1911.	1912.
Quantity, lb. . . .	6,567,181	9,858,774	7,593,711
Value, £	101,151	164,664	130,542

Attempts have been made by the Department of Agriculture to improve the quality of the cocoa produced, and as already mentioned in this BULLETIN (1913, **11**, 144), the Department recently undertook the preparation of a certain quantity of native-grown cocoa for the market. Experiments have been in progress on the fermentation and drying of cocoa beans, and two series of samples produced in the course of these experiments have been received at the Imperial Institute for examination.

SERIES I

The five samples of cocoa which are the subject of this report were received in January 1914.

No. 1.—"Fermented, and artificially dried for fifteen hours in rotary drier."

This sample consisted of fairly large unwashed beans of uniform size, plump and in good condition. In many cases the husk was cracked or broken away from the kernel. The fracture was frequently slatey. The flavour of the beans was mild and fairly pleasant.

No. 2.—"Fermented, dried in the sun for two hours, and then artificially dried for fourteen hours in rotary drier."

Unwashed beans of uniform size, plump, clean, and in good condition. The husk was brittle, but usually unbroken, and showed a white powdery bloom. The fracture in some cases was pale brown, but often of a purplish tint. The flavour was mild and fairly pleasant.

No. 3.—"Fermented, sun-dried for three hours, and then artificially dried in the rotary drier for nine hours."

These beans closely resembled those of sample No. 2, with the exception that beans with a slatey fracture were much less frequent.

No. 4.—"Fermented and sun-dried."

These beans were unwashed, of uniform size, fairly large, clean, and in good condition. The husk was unbroken. The fracture was similar to that of No. 3.

No. 5.—"Sample prepared on native farm; for comparison."

Unwashed beans of medium to fairly large size, but of rather dirty appearance. Some of the beans were plump, but the majority were somewhat shrivelled. The fracture was usually slatey.

The size, weight, etc., of the beans as received at the Imperial Institute were as follows:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Relative size, i.e. number of beans required to fill a 200 c.c. cylinder 5·3 cm. in diameter	76	81	75	71	95
Average weight of a single bean, in grams	1·33	1·30	1·34	1·47	1·11
Percentage of husk in beans	11·7	11·5	11·3	10·9	13·7

The beans, after removal of the husks, were analysed with the following results:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	4·7	4·5	4·3	4·2	4·6
Ash	2·5	2·5	2·5	2·5	2·6
Fat	49·9	46·5	46·8	49·5	47·3
Total alkaloids	1·77	1·58	1·80	1·62	1·63

In chemical composition the five samples of beans were of normal character, and showed no material difference.

The samples were too small to be submitted to manufacturers for trial, but they were sent for valuation to a firm of brokers, who reported that in their opinion the five products were all very good. They valued them as follows in Liverpool (March 1914):

Sample.	Price per cwt.
No. 1	57*s.*
No. 2	54*s.* 6*d.* to 55*s.* 6*d.*
No. 3	61*s.*
No. 4	60*s.*
No. 5	56*s.*

On the date of these valuations, "African" cocoa was quoted in Liverpool at 51*s.* 6*d.*–55*s.* 3*d.* per cwt., and in London as follows:

		Per cwt.
S. Thomé and Cameroons	Grey to colory	59*s.* to 62*s.*
East Coast	Good red	64*s.* to 75*s.*
British West Coast	Fair to good	48*s.* to 56*s.*

It is satisfactory that of these five cocoas from Nigeria, Nos. 3 and 4 were valued at rates very similar to those obtainable for S. Thomé cocoa, and that the other three were valued at prices equal to those obtainable for the best grades of British West African cocoa that now come on the market. Nos. 1 and 2, which were valued at lower rates than Nos. 3 and 4, in spite of their having been fermented, seem to have suffered somewhat from over-drying, as is shown in the brittleness and broken condition of the husks, and the curious cheese-like appearance shown by some of the fractured beans in these two samples was probably due to the same cause.

Series II

Two samples of cocoa which had been prepared by heating the beans at a suitable temperature in a rotary drier without previous fermentation were received in January 1914.

No. 6.—This sample consisted of unwashed, clean, plump, fairly large beans, having a brown husk, which was brittle and in most cases broken. The beans broke easily, the fracture being of a purple colour. The flavour was somewhat harsh and bitter.

No. 7.—Clean, plump, fairly large beans, having a pale brown husk with dark brown patches. The beans broke fairly easily, the fracture being of a curious slatey purplish-brown colour. The flavour was rather harsh.

The size, weight, etc., of the beans as received at the Imperial Institute were as follows:

	No. 6.	No. 7.
Relative size, i.e. number of beans required to fill a 200 c.c. cylinder, 5·3 cm. in diameter	77	75
Average weight of a single bean, in grams	1·28	1·32
Percentage of husk in beans	9·7	11·7

The beans, after removal of the husks, were analysed with the following results, indicating a normal composition:

	No. 6. *Per cent.*	No. 7. *Per cent.*
Moisture	4·0	3·5
Ash	3·2	3·5
Fat	48·7	48·6
Total alkaloids	1·92	1·87

The samples were submitted to a firm of brokers in Liverpool, who reported that they were of good quality, No. 6 being worth 54*s*. 6*d*. to 55*s*. 6*d*. per cwt., and No. 7 54*s*. to 55*s*. per cwt.

These samples, although unfermented, were valued at comparatively good prices, as will be seen by comparing the prices of African cocoa on the same date, quoted on p. 215.

It is clear, however, that treatment of cocoa beans in a rotary drier, without previous fermentation, will not yield a product as valuable as the fermented and dried cocoas represented by samples 3 and 4 dealt with in the preceding report, which were valued at 61*s*. and 60*s*. per cwt. respectively.

COPALS FROM BRITISH WEST AFRICA

THE chief sources of copal are East Africa, West Africa, the Dutch East Indies, certain islands in Polynesia, New Zealand, New Caledonia, and the north-eastern parts of South America. The East African product, known in commerce as Zanzibar animi or copal, is a fossil kind found chiefly in localities from which copal trees have now disappeared. The copal of New Zealand and New Caledonia is better known in trade as Kauri copal, and is also a fossil product derived originally from the Kauri pine, *Dammara australis*. The Dutch East Indian and Polynesian copals are entirely obtained from living trees, and chiefly from *D. orientalis*, while that from South America ("Demerara animi") is collected mainly from living trees of *Hymenœa Courbaril*, but is also found in the fossil form. The West African material is obtained throughout the coastal region from Sierra Leone to the Portuguese Congo territory, and is of very variable quality, the best sorts being fossil or semi-fossil and the medium and poorest qualities being procured from living trees. The exports of copal from British territories in West Africa in recent years are shown in the following table:

	1910.		1911.		1912.	
	cwts.	£	cwts.	£	cwts.	£
Sierra Leone	644	3,331	555	2,966	340	1,607
Southern Nigeria	269	459	205	363	1,454	1,686
Gold Coast	481	647	715	1,110	599	1,077

Copal from each of the above countries has already been dealt with in this Bulletin (1907, **5**, 16; 1908, **6**, 245); further samples from Nigeria and the Gold Coast have been examined recently, and an account of these is given below.

Nigeria

Three samples of copal, described as "ozia" gum and derived from *Daniella Ogea*, Rolfe (= *Cyanothyrsus Ogea*, Harms), were received from Benin, Southern Provinces, in June 1909. No information regarding the method of preparation of these copals was supplied, other than the statement that they represented 1st, 2nd, and 3rd grades. They were as follows:

No. 1 *Grade.*—This sample consisted of (1) a cake of resin, weighing ½ lb., of pale yellow colour and free from foreign matter; and (2) small irregularly-shaped fragments, varying in colour from almost white to pale brown. The surfaces of the fragments were dull and covered with a thin coating of dust. The resin showed a conchoidal fracture. It was hard, and possessed a slight, pleasant odour.

No. 2 *Grade.*—Small irregular-shaped fragments of resin, of fairly uniform pale brown colour. The surfaces were dull and often covered with a thin "weathering" crust. Some pieces were clear, others partially opaque. The resin was hard, and possessed a faint, pleasant odour.

No. 3 *Grade.*—Fragments of fairly hard resin, varying in colour from pale yellow to dark brown, and covered with a thin "weathering" crust. Considerable quantities of dirt, pieces of bark, etc., were present. The resin had a faint, pleasant odour, especially when rubbed.

The samples were examined with the following results:

	No. 1.	No. 2.	No. 3.
Moisture . . . *per cent.*	0·25	1·85	0·93
Ash . . . . *per cent.*	0·25	0·25	0·21
Melting point[1]	100° C. (approx.)	115° C.	110° C.
Acid number[2]	110	123	119
Solubility in—			
Alcohol	Insoluble	Partly soluble	Partly soluble
Ether	Largely soluble	Partly soluble	Partly soluble
Benzene	Partly soluble	Slightly soluble	Insoluble
Alcohol and benzene . .	Nearly completely soluble	Nearly completely soluble	Nearly completely soluble
Turpentine oil . . .	Insoluble	Partly soluble	Partly soluble
,, ,, and benzene .	Swells up	Partly soluble	Insoluble
Alcohol and turpentine oil .	Partly soluble	Nearly completely soluble	Insoluble

[1] *Determined on the powdered copal in a capillary tube.*

[2] *Milligrams of potassium hydroxide required to neutralise one gram of copal.*

Samples Nos. 1 and 2 were "melted" to render them soluble in turpentine oil, and they lost 29 and 19·5 per cent. in weight, respectively, in the process. The resulting "melts" were dissolved in turpentine oil, yielding in each case a clear varnish of high brilliance, that produced from sample No. 1 having very little colour, whilst the other was pale yellow. It was found impossible to prepare a varnish in the same way from sample No. 3, as on melting it gave a very dark-coloured product which frothed up.

The samples were submitted for valuation to brokers and to a firm of varnish manufacturers. The latter reported that all the copals were rather below standard in regard to their melting points, and that they could not be strongly recommended for varnish-making purposes. The brokers' report was as follows (March 1910):

Sample.	Description.	Value. *Per cwt.*
No. 1.	Good quality, Accra kind . .	45*s.* to 47*s.* 6*d.*
No. 2.	Medium quality, Accra kind . .	35*s.*
No. 3.	Low quality, Accra kind . .	25*s.*

General Conclusions

This kind of copal is at best an inferior product as compared with the best kinds of fossil copal, such as those produced in East Africa, and known in commerce as Zanzibar copal, and that collected in New Zealand

and known as Kauri copal. Very fine copals of these types may fetch up to £500 per ton.

Apart from the matter of intrinsic quality, all crude copals can be improved by cleaning and "picking." The former operation is usually only necessary in the case of crude copals coated with a layer of "weathered" products. The object is to produce a bright clean surface, and for this purpose the crude copal is broken into pieces about 1 in. to 1½ in. cube, or smaller if convenient, all pieces of bark, etc., being removed, and placed for 24 hours in a tub with a dilute solution of caustic soda. A solution of about ½ per cent. strength should be enough in the case of copals such as these from Nigeria. The copal should be stirred up gently from time to time with a wooden stick, and after the treatment it should be washed several times in fresh water, any loosely adhering flocculent matter being brushed away, and any remaining fragments of bark, leaves, etc., scraped off with a blunt knife. It should then be spread out in a convenient place to dry. It is then ready for "picking," which consists in separating the crude copal by hand-picking, according to colour; the palest-coloured pieces are the best, and fetch the highest prices, and the dark-brown or almost black and opaque pieces are of least value. Each grade should consist of pieces of uniform colour and nearly uniform in size. The dust and chips should be kept separate and sold as lower grades.

Of the samples submitted in the present instance, the first grade merely requires breaking into uniform pieces and "picking," whilst Nos. 2 and 3 require to be cleaned to free them from bark, etc., then washed in alkali as described above, and finally "picked" according to colour. Treated in this fashion, the palest, clearest resin would probably fetch about 75*s.* per cwt. (March 1910), and the poorest grades would probably bring little if anything less than the price now quoted for the 3rd grade sample.

Gold Coast

Two samples of copal collected in the Dunkwa district of the Gold Coast were received in November 1913. The

ordinary Accra copal is derived from *Daniella similis*, Craib, but no information was supplied as to the origin of the present samples.

No. 1.—This consisted of a single piece of hard, transparent, pale yellow resin, clean and smooth externally, and free from foreign matter.

No. 2.—This was an irregular mass of hard, transparent, pale golden-brown resin, clean, but rough externally, and containing traces of foreign matter within.

The samples were analysed with the following results, compared with corresponding figures for copal from the Gold Coast previously examined at the Imperial Institute.

	Present samples. No. 1.	No. 2.	Previous samples.
Moisture . . *per cent.*	0·8	2·8	—
Ash . . *per cent.*	0·03	0·06	0·1 to 2·2
Melting point . . .	115° C.	115° C.	120° C. to 180° C.
Acid number . . .	101·8	129·1	124 to 134
Saponification number .	107·3	135·8	—

The copals were "melted" to render them soluble in turpentine oil, losing 14·7 and 14·6 per cent. in weight respectively in the process. The resulting "melts" were dissolved in twice their weight of turpentine oil, yielding in each case a varnish which dried hard, pale, and lustrous.

The solubility of the samples was tested, with the following results, which were identical in the two cases:

Solvent.	Solubility of samples (No. 1 and No. 2).
Alcohol	Partly soluble.
Ether	Do. do.
Alcohol and ether	Completely soluble.
Chloroform	Partly soluble.
Benzene	Do. do.
,, and alcohol	Completely soluble.
Turpentine oil	Partly soluble.
,, ,, and alcohol . .	Completely soluble.
,, ,, and benzene . .	Partly soluble.

These results are generally similar to those obtained for the solubility of samples of copal from the Gold Coast previously examined at the Imperial Institute.

The copals were submitted to a firm of brokers in Liverpool, who stated that if the material could be marketed in pale-coloured, clean, large pieces like the present samples, it would realise a very high price in the United Kingdom, possibly as much as 90*s.* to 100*s.* per cwt. (March 1914). If, however, it is only possible to offer the product in the condition of the ordinary Gold Coast copal now shipped to Liverpool, *i.e.* containing small fragments, dust, and dirt, it would have a similar value to the latter material, viz. 47*s.* to 51*s.* per cwt. for fairly clean parcels in good condition, or smaller prices, down to as little as 35*s.* per cwt. for inferior qualities (March 1914).

Copal of the kind represented by the present samples would be readily saleable in the United Kingdom, but, as indicated above, the prices obtainable would depend on the quality and the grading of the material.

ESSENTIAL OILS FROM VARIOUS COUNTRIES

Lemon Grass Oil from India

Five samples of commercial Cochin lemon grass oil were forwarded to the Imperial Institute by the Director of Agriculture at Madras in February 1913. They were sent as the result of statements that the Cochin lemon grass oil marketed in the United Kingdom had recently begun to show signs of "insolubility" (cf. Parry, *Perfumery and Essential Oil Record*, 1913, **4**, 40, and Umney, *loc. cit.* p. 119). In this connection it may be explained that hitherto two kinds of lemon grass oil have been recognised in commerce, viz. that typified by Cochin oil, which is "soluble" in 2 or more volumes of 70 per cent. alcohol, and that represented typically by West Indian oil, which is "insoluble" in 70 per cent. alcohol (cf. this Bulletin, 1911, **9**, 334).

The samples were examined in order to determine their solubility in 70 and 80 per cent. alcohol, and the results obtained are given in the following table:

Number of sample.	Description.	Solubility in 70 per cent. alcohol.	Solubility in 80 per cent. alcohol.
1	Kayan Kalam lemon grass oil.	Soluble to a clear solution in 2 vols.	—
2	Alwaye lemon grass oil . .	Soluble to a clear solution in $1\frac{3}{4}$ vols.	—
3	Alwaye lemon grass oil . .	Not soluble to a clear solution in 5 vols.	Soluble in $\frac{2}{3}$ vol., becoming cloudy on the addition of 2 vols.
4	Cochin lemon grass oil . .	Ditto.	Soluble in $\frac{2}{3}$ vol., becoming cloudy on the addition of 4 vols.
5	Alwaye lemon grass oil . .	Ditto.	Ditto.

Samples Nos. 4 and 5 were too small for detailed examination, but the first three oils in the above list were further examined with the following results:

	No. 1.	No. 2.	No. 3.
Specific gravity at $\frac{15° C.}{15° C.}$	0·901	0·917	0·908
Optical rotation a_D .	$-5°\ 35'$ (at 21° C.)	not determined.	about $-2°$ (at 19° C.)
Aldehydes (by bisulphite method) *per cent.*	68·5	77	73

These results show that three of the five oils (Nos. 3, 4, and 5) would be classed as "insoluble," and support the statement that the proportion of "insoluble" oil from Cochin has increased recently.

As it was considered that this change in the character of the lemon grass oil shipped from Cochin might be due either to the employment of a variety of lemon grass different from that formerly used, or to a change in the method of distillation, further specimens of oil, obtained from the different kinds of grass used, were requested for examination.

Two samples of oil were accordingly submitted in August 1913, one distilled from "white stemmed" and the other from the "red stemmed" grass. The Director of Agriculture stated that both varieties grow wild, but that it is reported that in North and Central Travancore the red stemmed variety is cultivated to some extent. He mentioned that the oil is extracted from the wild and cultivated grasses indiscriminately.

"*White stemmed.*"—This was a cloudy yellow oil, with an odour more nearly resembling that of a citronella oil than that of a lemon grass oil. It gave the following results on examination:

	Oil from "white stemmed" grass.	Ceylon citronella oil, for comparison.
Specific gravity at $\frac{15° C.}{15° C.}$	0·909	0·900 to 0·920
Optical rotation α_D .	$-$ 10° 50′ (at 22° C.)	$-$ 7° to $-$ 22°
Absorbed by sodium bisulphite . *per cent.*	9	7 to 10
Solubility:		
In 80 per cent. alcohol	Soluble in 0·8 or more vols., becoming slightly turbid with 4 vols.	Dissolves to a clear solution with 1 to 2 vols.; with 10 vols. remains clear or shows only slight opalescence.
In 70 per cent. alcohol	Not soluble in 5 vols.	—

On shaking the oil with 5 vols. of 70 per cent. alcohol and allowing the mixture to stand, a clear separation of oil took place on top of the solvent.

This oil resembled a citronella oil rather than a true lemon grass oil, and it was therefore requested that herbarium specimens of the grass should be forwarded for determination. These have not yet been received.

"*Red stemmed.*"—This was a clear reddish-brown oil, possessing the usual odour of lemon grass oil. It gave the following results on examination:

	Oil from "red stemmed" grass.	East Indian lemon grass oil, for comparison.
Specific gravity at $\frac{15° C.}{15° C.}$ . .	0·925	0·899 to 0·905
Optical rotation α_D . . .	The oil was too dark for this observation.	+ 1° 25′ to $-$ 5°
Absorbed by sodium bisulphite *per cent.*	71·5	70 to 85
Solubility:		
In 80 per cent. alcohol . .	Soluble in 0·8 or more vols., becoming slightly turbid with 5 vols.	—
In 70 per cent. alcohol . .	Did not dissolve to a clear solution in 5 vols.	Soluble in 1·5 to 3 vols.

On shaking the oil with 5 vols. of 70 per cent. alcohol and allowing the mixture to stand, a few globules of oil separated at the bottom of the solvent.

In order to ascertain the cause of the insolubility of the "red stemmed" lemon grass oil in 70 per cent. alcohol, as compared with ordinary East Indian lemon grass oil, the following experiments were carried out:

(1) The oil was steam-distilled, until a distillate equivalent to 65 per cent. of the original oil was obtained. This distillate was of a bright yellow colour, whilst the residue of 35 per cent. was a reddish-brown viscous oil. The distillate and residue exhibited the following solubilities:

	Distilled oil.	Residual oil.
In 70 per cent. alcohol .	Soluble in 2·4 vols., and remaining clear on dilution	Insoluble in 12 vols.
In 80 per cent. alcohol .	—	Soluble in 0·9 vol., becoming turbid with 4 vols.

(2) The oil was steam-distilled until oil ceased to distil over. The distillate then amounted to 78·7 per cent. of the original oil. It was of a bright yellow colour, whilst the residual oil was dark reddish-brown, viscous, and slightly heavier than water.

The distillate contained 81 per cent. of aldehydes, as determined by sodium bisulphite absorption, and was soluble in 2·4 vols. of 70 per cent. alcohol, the solution remaining clear on further addition of alcohol.

These experiments indicate that the more volatile portions of the "red stemmed" lemon grass oil satisfy the test for solubility in 70 per cent. alcohol, whereas the less volatile portions do not. The insolubility of the entire oil is therefore apparently caused by the inclusion of these less volatile fractions of oil, the presence of which is probably due to the distillation having been carried too far.

Vetiver Oil from Fiji

The sample of vetiver oil which is the subject of this report was received at the Imperial Institute in April 1913. It consisted of a viscous, yellowish-brown oil, having the characteristic odour of vetiver. On exposure to air and light for a short time the colour became dark green.

The oil was examined with the following results, compared with the corresponding figures for a previous sample

from Fiji which was examined at the Imperial Institute (this Bulletin, 1912, **10**, 32):

	Present sample.	Previous sample.
Specific gravity at $\frac{15° C.}{15° C.}$ . .	1·018	1·0298
Solubility in 80 per cent. alcohol	Soluble in $1\frac{1}{3}$ vol., becoming turbid with 3 or more vols.	Soluble in 2·5 vols., becoming turbid with more.
Saponification number . .	47	35·3

The optical rotation could not be determined, owing to the dark colour of the oil.

For comparison with these results the following analyses of other vetiver oils may be quoted:

	Vetiver oil purchased by the Imperial Institute in London.		German distilled vetiver oil (recorded by Gildemeister and Hoffmann).
Origin.	Java.	Réunion.	—
Specific gravity at $\frac{15° C.}{15° C.}$	1·044	1·001	1·015 to 1·030
Solubility in 80 per cent. alcohol . . .	Soluble in 1 vol. or more.	Soluble in 1 vol. or more.	Soluble in 1·5 to 2 vols.; becoming turbid with more.
Saponification number .	56·0	10·6	60 to 80

It will be seen that the present sample of Fiji vetiver oil differs considerably from the sample previously examined, but it still resembles the "heavy" vetiver oils produced in Europe, rather than the "light" vetiver oil distilled in Réunion.

There is considerable difficulty in getting definite valuations of vetiver oils from new localities at the present time, partly because the supply of vetiver oil has outstripped the demand, and partly because the "light" vetiver oil produced in Réunion appears to be replacing "heavy" vetiver oils to some extent. Apart from these difficulties there is the fact that the value of a vetiver oil is finally decided largely on the commercial expert's personal taste. The vetiver oils produced in different countries no doubt all possess the characteristic vetiver odour, but each has peculiarities of its own, which naturally affect the expert's opinion of its value.

As the present sample of oil received from Fiji was small, it could only be submitted to three experts for trial

and valuation, and the following is a summary of their reports, which serve to illustrate the difficulty there is in arriving at even an approximate valuation of a product when the tests on which reliance is placed are purely subjective:

(1) A sample of the oil was submitted to a German firm of essential oil distillers, who examined it, and reported that although not quite equal to the best vetiver oils produced in Europe it was of good quality and should realise a wholesale price of 25*s.* to 30*s.* per lb., landed terms (June 1913). They added that there is only a restricted demand for vetiver oil, and that in their opinion this demand is amply met by existing sources of supply.

(2) A firm of oil distillers in London reported that the constants of the oil were about normal, but that the odour was considerably inferior to that of Indian vetiver and more resembled that of Bourbon (Réunion) oil, though it was inferior to the latter. The firm stated that it was difficult to estimate the commercial value of the oil, but they were of opinion that it would be worth about 16*s.* per lb. in London (July 1913). They pointed out that there is not a great demand for vetiver oil, and that if it were produced on a large scale a considerably lower price would have to be accepted for it. The value of Bourbon vetiver oil on the same date was about 30*s.* per lb. in London.

(3) A London dealer in essential oils reported that the oil appeared to be of good quality, but that it was difficult to estimate its value. He was however of opinion that the oil was not of sufficient commercial interest to find a large market.

Oil of Limes from Fiji

A sample of distilled oil of limes was also received from Fiji in April 1913. The oil was pale yellow in colour and possessed the characteristic odour of distilled oil of limes. It was examined with the following results, which are compared with those recorded for West Indian distilled oil of limes:

	Present sample.	West Indian distilled oil.
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	0·868	0·856 to 0·868
Optical rotation α_D at 21° C.	+ 37° 6′	about + 40°

This oil closely resembled the ordinary distilled oil of limes imported from the West Indies, the current value of which on the date of the report was from 2*s.* 6*d.* to 2*s.* 9*d.* per lb. in London (December 1913).

Ylang-Ylang Oil

Seychelles

The results of examination of three samples of ylang-ylang oil from the Seychelles have been published previously in this Bulletin (1908, **6**, 110). Further samples were received in May 1909 and November 1913 respectively, and an account of the results of examination of these is given below.

The oil received in 1909 was pale yellow, faintly cloudy, and possessed the characteristic odour of oils derived from the flowers of *Cananga odorata*. It furnished the following constants on examination:

Specific gravity at 15° C.	0·920
Optical rotation a_D at 21° C.	– 30°
Saponification value	46·4
Acid value	4·2
Ester value	42·2
Solubility in 90 per cent. alcohol	1 in 1, but not more

The results of the chemical examination of the oil show that its constants do not agree with those of true ylang-ylang oil, but with those of cananga oil, and no firm which purchases essential oils on the basis of chemical examination would accept this Seychelles oil as a true ylang-ylang oil.

The oil was submitted for valuation to experts in this country and on the continent; but considerable difference of opinion was expressed as to the character of the oil. Two firms regarded it as cananga oil, and one of these valued it at 8*s.* per lb. in the crude state. Another firm, however, regarded it as ylang-ylang oil, though not so delicate or refined in odour as the Manila product. This difference of opinion, as to the category in which this oil should be placed, is probably explained by the circumstance that the third firm referred to appear to have valued the oil on its odour alone.

A portion of the oil now under report was re-examined after a lapse of over three years, in order to ascertain whether it had altered to any considerable extent. The results showed, however, that the oil had not changed very greatly since it was first examined, the only noteworthy feature being that the ester value showed a slight increase (see next table).

The sample received in 1913 consisted of bright, pale yellow ylang-ylang oil. It was examined with the following results, compared with the corresponding figures for the previous sample from Seychelles.

	Present sample.	Previous sample. First examination.	Previous sample. Second examination, after keeping for over three years.
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	0·9567	0·9200	0·9250
Optical rotation α_D	− 28° 5′ at 20° C.	− 30° at 21° C.	− 28° 36′ at 24° C.
Acid value	3·3	4·2	2·6
Ester value	126·0	42·2	53·5
Saponification value	129·3	46·4	56·1
,, ,, after acetylation	181	—	—
Solubility in 90 per cent. alcohol	Gives a clear solution with less than 0·8 vol.; with 0·8 vol. or more, becomes turbid.	Soluble in 1 vol.; becoming turbid with a larger quantity.	Soluble in $\frac{1}{3}$ vol.; becoming turbid with 1 or more vols.

The present sample of oil differs markedly from the previous sample in containing a very much larger percentage of esters, and in having a higher specific gravity. Its constants agree with those recorded by Bacon for first-grade Manila ylang-ylang oil, as will be seen from the following figures:

	First grade.	Second grade.
Specific gravity at $\frac{30^\circ C.}{4^\circ C.}$	0·91 to 0·96	0·89 to 0·94
Optical rotation α_D at 30° C.	− 48° to − 26°	− 87° to − 27°
Ester value	90 to 169	42 to 89

It is thus clear that so far as constants are concerned this oil is more like a first-grade Manila ylang-ylang oil than the previous sample from Seychelles. Its odour,

however, on which the value of the oil finally depends, is not altogether pleasant, and is rather pungent.

In view of the smallness of the sample, and of the impossibility of obtaining supplies of the oil from Seychelles at present, it was not submitted to experts for valuation. It should, however, be pointed out that owing to great over-production of the oil, it is very difficult at present to sell ylang-ylang oil at remunerative prices unless it is of the first grade.

Mauritius

A sample of ylang-ylang oil from Mauritius was received in June 1913. It consisted of a turbid yellow oil, having a characteristic pleasant odour. The oil was examined with the following results:

Specific gravity at $\frac{15° C.}{15° C.}$	0·9883
Optical rotation a_D at 20° C.	− 30°
Acid value	7
Ester value	173
Saponification value	180
„ „ after acetylation	211
Esters, expressed as acetate of $C_{10}H_{18}O$, *per cent.*	60·55
Alcohols, *free*, expressed as $C_{10}H_{18}O$, *per cent.*	10·76
„ *combined* „ *per cent.*	47·58
Solubility in 90 per cent. alcohol	The oil gave a clear solution with 0·1 to 2·5 vols., becoming turbid on further dilution.

The above results indicate that the constants of this oil are somewhat abnormal when compared with those of the best grades of ylang-ylang oil (see table on p. 229), the specific gravity and ester value being higher than the figures usually found for the latter oils.

Samples of the oil were submitted to two firms of essential oil merchants in London, and also to two Continental firms, with the following results:

(1) One of the London firms reported that the oil possessed characteristics distinct from those of any ylang-ylang oil which they had examined previously, or of any

oil for which figures have been published. They stated that such characteristics in ordinary ylang-ylang oil would be regarded with suspicion, and they would not accept this product as a substitute for the normal ylang-ylang oil. They added, however, that the odour was good, and that the peculiar characteristics were probably due to the district in which the oil was produced; and, regarding it as a pure oil, they valued it on its merits at about 4*s*. per oz. The firm added that this Mauritius oil would not of course compare in odour with the finest ylang-ylang oil from Manila, the current value of which was about 12*s*. to 13*s*. per oz. in London, according to the brand (December 1913).

(2) The second London firm reported that in their opinion the sample was of very good quality, but that as the market is overloaded at present probably not more than 3*s*. per oz. could be obtained for the oil (December 1913). They added that if the oil was available in commercial quantity they would be prepared to purchase it at about this price.

(3) A firm of distillers in France reported that the odour of the oil was not very delicate, and suggested that this defect was perhaps caused by carrying the distillation of the flowers too far. They were of opinion that such oil would not be saleable in the present state of the market.

(4) A German firm considered the sample to be of indifferent character, and barely equal to what is commercially regarded as middling quality ylang-ylang oil. They stated that there has been heavy over-production in the lower grades of this oil in recent years in Réunion and elsewhere, and that consequently it has become very difficult to dispose of anything but first-grade oils at remunerative prices.

In view of the foregoing reports it appears that under present conditions ylang-ylang oil of the quality of the sample under report would probably not realise more than about 3*s*. to 4*s*. per oz. in the London market. It was suggested, therefore, that efforts should be made in Mauritius to produce an oil of superior quality by careful

attention to the degree of ripeness of the flowers, and the regulation of the distillation.

CLOVE OIL FROM MAURITIUS

Two samples of clove oil from Mauritius were received in September 1913.

No. 1.—This was a pale reddish-brown oil, possessing the strong aromatic odour and pungent taste characteristic of oil of cloves.

No. 2.—This oil closely resembled sample No. 1, but was superior to it in odour. It was slightly cloudy owing to the presence of moisture.

The samples were submitted to chemical examination with the following results, which are shown in comparison with the range of constants recorded for commercial clove oil:

	No. 1.	No. 2.	Commercial clove oil.
Specific gravity at $\frac{15° C.}{15° C.}$.	1·061	1·067	1·047 to 1·070
Optical rotation a_D at 22° C.	– 0° 10′	– 0° 5′	0° to – 1° 30′
Eugenol . . *per cent.*	89	95	85 to 95
Solubility in 70 per cent. alcohol.	Soluble in 1·5 vol. or more.	Soluble in 1·25 vol. or more.	Soluble in 2 vols.

The oils were submitted to several firms of oil distillers and merchants in the United Kingdom and abroad, who reported on them as follows:

(*a*) One firm stated that the oils were dark in colour and lacked "body," but should be saleable for the preparation of eugenol at a price of about ½*d.* per lb. for each 1 per cent. of eugenol present. Thus, an oil containing 90 per cent. of eugenol would be worth 3*s.* 9*d.* per lb. (February 1914).

(*b*) A second firm reported that the odour of the samples was characteristic of clove oil, but not equal to that of the oil distilled in the United Kingdom, whilst the colour of the samples was too dark and the density very high, these remarks being especially applicable to sample No. 2. They were, however, of opinion that the high percentage of eugenol present would render these oils of special value in the preparation of vanillin. The firm added that better

methods of distillation would probably improve the quality of the oils.

(*c*) A German firm reported that the samples exhibited normal properties, and represented clove oils of good commercial value, which should be saleable at about 8 marks per kilogram (February 1914), a value quite similar to that quoted above.

(*d*) A fourth firm reported that the samples were of fair average quality, although they did not consider the aroma to be quite equal to the standard of the best English distilled clove oil, whilst the colour was rather dark, and would in many quarters be considered an objection. They added that the current price of the best clove oil was about 3*s.* 6*d.* per lb. (February 1914), and they therefore valued these Mauritius oils at rather less.

From the results of this investigation it is evident that these Mauritius clove oils, although somewhat inferior in colour and aroma to the best clove oils distilled in the United Kingdom, are nevertheless of good quality. There is no doubt that consignments of such oils would meet with a ready sale in Europe.

The yields of clove oil obtained in these trials in Mauritius appear to have been rather low, viz. 11·5 and 10·2 per cent. respectively, as against an average yield of about 15 to 18 per cent. obtained by the distillation of cloves in Europe. It is possible, however, that the cloves used in these trials in Mauritius were not so dry as those usually imported into Europe.

Clove Leaf Oil from Mauritius

Three clove leaf oils from Mauritius were also received in September 1913.

No. 1.—This was a light reddish-brown oil possessing the strong aromatic odour and pungent taste characteristic of clove leaf oil.

No. 2.—This oil closely resembled No. 1, but was somewhat darker in colour.

No. 3.—This oil closely resembled No. 2.

The samples were submitted to chemical examination at the Imperial Institute with the following results ;

	No. 1.	No. 2.	No. 3.
Specific gravity at $\frac{15° C.}{15° C.}$	1·062	1·059	1·065
Optical rotation α_D at 22° C.	− 0° 28′	(Nos. 2 and 3 were too dark for this determination.)	
Eugenol . . *per cent.*	91	90	90
Solubility in 70 per cent. alcohol.	In each case the oil was soluble in 1·25 vol. or more.		

These results agree fairly well with those previously obtained at the Imperial Institute for clove leaf oils from Zanzibar and Seychelles (this Bulletin, 1908, **6**, 111; 1913, **11**, 438).

The oils were submitted to several firms of oil distillers and merchants in the United Kingdom and abroad, who reported on them as follows:

(*a*) One firm reported that the oils were dark in colour and lacked "body." They would, however, be saleable for the preparation of eugenol, and for this purpose should be worth ½*d.* per lb. for each 1 per cent. of eugenol which they contained. Thus, an oil containing 90 per cent. of eugenol would be worth 3*s.* 9*d.* per lb. (February 1914).

(*b*) A second firm placed the samples, according to quality, in the order Nos. 1, 2, 3, No. 1 being the best. They stated that on account of their richness in eugenol the oils should be of value for the manufacture of vanillin, and that if the colour could be improved they should also find a market for perfumery purposes.

(*c*) A German firm reported that the samples exhibited normal properties, and should be worth as much as clove-stem oil, viz. about seven marks per kilogram (February 1914).

(*d*) A fourth firm stated that the value of the oils would be based entirely on their eugenol content, as the samples (especially Nos. 2 and 3) were deficient in aroma and dark in colour; and that their principal application would be in the manufacture of vanillin, for which purpose they would probably realise rather less than the current price of clove oil. The firm added, however, that the actual value of the products could only be ascertained by practical experiments on a manufacturing scale.

The foregoing reports indicate that these clove-leaf oils are of satisfactory quality and would be readily saleable for

the extraction of eugenol, which is largely used for the manufacture of vanillin.

The yield of oil obtained from the clove leaves in these trials in Mauritius appears to be small even under the best conditions, viz. 1·62 per cent. Clove leaves from the Seychelles distilled at the Imperial Institute in 1907 yielded 4·5 per cent. of oil (this BULLETIN, 1908, **6**, 111).

SANDALWOOD OIL FROM MAURITIUS

The three samples of sandalwood oil which are the subject of this report were received at the Imperial Institute in September 1913. They were stated to have been distilled from the wood of *Santalum album*, and it was desired to ascertain their commercial value in Europe.

No. 1 (pale) (from heartwood).—This was a somewhat viscid oil, of light yellow colour, and possessing the characteristic aromatic odour and taste of sandalwood oil.

No. 2 (dark) (from heartwood).—This was of similar character to No. 1 (pale), but was of a yellowish-brown colour.

No. 3 (from sapwood).—This oil closely resembled No. 2 (dark) in appearance.

The three oils were all slightly cloudy owing to the presence of moisture.

The samples, after the removal of the moisture they contained, were submitted to chemical examination with the following results, compared with the corresponding average figures for commercial sandalwood oil:

	No. 1 (pale).	No. 2 (dark).	No. 3.	Commercial sandalwood oil.
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	0·9788	0·9804	0·9814	0·974 to 0·985
Optical rotation a_D at 22° C.	−21° 19′	−20° 19′	−20° 36′	−16° to −20° 45′
Acid value	1·4	1·7	2·2	0·5 to 8·0
Saponification value	4·7	3·9	2·8	3·17
Saponification value after acetylation	199·7[1]	203·3[1]	203·0[1]	not below 196[1]
Solubility in 70 per cent. alcohol	Soluble in 5½ vols. or more at 15° C.	Soluble in 5½ vols. or more at 15° C.	Soluble in 5½ vols. or more at 15° C.	Soluble in about 5 vols.
Calculated for santalol $C_{15}H_{24}O$. *per cent.*	93·10	95·02	94·93	at least 90

From these results it is evident that the Mauritius oils contain a satisfactory proportion of santalol, and that, in general, their constants correspond with those of ordinary commercial sandalwood oils.

The three oils were submitted to several firms of essential oil distillers and merchants in the United Kingdom and abroad, who reported on them as follows:

(*a*) One firm reported that the oils were rather dark in colour, and had a somewhat earthy odour. They pointed out that the yields stated to have been obtained in Mauritius, in no case exceeding 1·58 per cent., are very low, the normal yield being about 4 per cent.; and they suggested that the wood was not ground finely enough, and that it would be better to export the wood itself than to attempt to distil the oil in the Colony on a commercial scale.

(*b*) A second firm reported that sample No. 1 (pale) was of characteristic odour, and in their opinion compared favourably with the oil distilled from East India sandalwood, but that the colour of No. 2 (dark) and No. 3 was too dark, and their odour inferior. The firm considered that better methods of distillation would probably improve the colour of these oils.

(*c*) A German firm considered that the oils would compete favourably with good commercial sandalwood oil, and valued them at about 44 marks per kilogram (February 1914), adding that two years ago the corresponding price would have been only 20 marks per kilogram.

(*d*) A fourth firm reported that the samples appeared to be of very good quality, but were rather darker in colour than is usual with sandalwood oil, whilst they would also require filtration. The firm stated that the current market value of good foreign sandalwood oil was 20*s*. to 21*s*. per lb., and that of the finest English sandalwood oil 22*s*. to 23*s*. per lb. in London (February 1914), adding that the prices had risen considerably of late owing to the higher price of sandalwood, the normal value of the oil having been for many years from 10*s*. to 12*s*. per lb. It will be seen that these figures are similar to those quoted by the German firm mentioned above.

These sandalwood oils from Mauritius appear to be, on the whole, of good quality, and there is no doubt that consignments of such oils would be readily saleable in Europe.

COHUNE NUTS FROM BRITISH HONDURAS

A REPORT on cohune nuts was printed in this BULLETIN last year (1913, **11**, 226). The number of the BULLETIN containing the report was sold out very soon after it was published, and as enquiries on this subject are still being received, it seems desirable to reprint the report, so that it may be readily available for general information. An analysis of the meal, left after the extraction of the oil from the kernels, has been made at the Imperial Institute since the report was first published, and the results of this analysis have been added.

Cohune nuts are derived from the cohune palm (*Attalea Cohune*), a native of British Honduras, where it is said to occur over an area of nearly 2,000,000 acres, or two-fifths of the total area of the colony. It is the characteristic plant of the "cohune ridges," a term applied to the low-lying lands bordering river valleys, or occupying extensive tracts or basins, as in the west and south, or at the heads of some of the rivers.

The nuts are borne in large bunches, and each tree is said to yield 1,000 nuts per annum (*Colonial Reports*, *Annual*, No. 73, *Report on British Honduras for* 1891 [Cd. 6857–23], p. 21). This estimate, however, is probably too low, and in one case brought to the notice of the Imperial Institute the yield of nuts per tree was 2 cwts., *i.e.* about 2,000 nuts. The kernels are rich in oil; but so far they have not been utilised on a commercial scale, chiefly owing to the difficulty of cracking the very hard shells which surround them. Several machines have been devised for this purpose, and certain of these are now under trial in British Honduras.

The oil yielded by the kernels was examined at the Imperial Institute some years ago, and the results pub-

lished in this BULLETIN (1903, 1, 25). Since that date a number of samples of cohune fruits and kernels have been received from British Honduras, and the results of their examination are given in the succeeding pages.

A sample of cohune kernels, measuring about $1\frac{1}{4}$ to $1\frac{1}{2}$ in. in length, and $\frac{3}{4}$ to 1 in. in diameter, was received in April 1912. Scarcely any of the kernels were quite undamaged, and many of them were badly damaged. The sample yielded 71·8 per cent. of solid white fat, resembling coconut oil in appearance. As this yield was considerably more than that obtained from the earlier sample, further specimens were asked for in order that the average yield of fat might be determined.

In response to this request three samples of fruits and two of kernels, stated to have been obtained from palms on the Belize River, were forwarded from British Honduras in September 1912. These samples were as follows:

(1) Large brown fruits.—These measured about $2\frac{1}{2}$ to $2\frac{3}{4}$ in. in length, and about $1\frac{1}{2}$ to 2 in. in diameter; they were rounded at the base and pointed at the apex. The papery, leaf-like bracts had in most cases become detached from the bases of the fruits in transit.

The fruits had a tough outer fibrous layer enclosing the nut; this outer layer was about $\frac{1}{8}$ in. thick, and contained a small proportion of fat. The nuts, which measured 2 to $2\frac{1}{4}$ in. in length and about $1\frac{1}{2}$ in. in diameter, had a hard, woody shell, about $\frac{3}{10}$ in. thick, and extremely difficult to crack, enclosing an oily kernel; occasionally two kernels were present. The kernels, which were about 1 to $1\frac{1}{4}$ in. long and $\frac{5}{8}$ in. in diameter, resembled ordinary palm kernels in general appearance, but were of a more elongated shape. The average weight of an entire fruit was about 50 grams.

(2) Small fruits resembling those of sample 1, but without bracts. The average weight of a single fruit was 45 grams.

(3) Fruits of a rather darker colour, more rounded in shape, and slightly smaller than those of sample 1. The average weight of a single fruit was 48 grams.

(4) Whole kernels.—These resembled those extracted from the fruits of samples 1, 2, and 3. A fair proportion

of broken kernels was present. The average weight of a kernel was 5·2 grams.

(5) Broken kernels.

The fruits of samples 1, 2, and 3 were found to have the following composition:

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.
Outer fibrous layer	33·2	15·1	22·6
Nut { Shell	58·0	71·3	66·5
Nut { Kernel	8·6	13·6	10·9

The percentage of kernel in the fruits therefore varied considerably in the three samples.

Outer fibrous Layer.—The percentages of moisture and fat present in the outer fibrous layer of the fruits were determined with the following results:

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.
Moisture	9·6	8·4	10·2
Fat	16·9	20·6	9·3

It will be seen that the percentage of fat in the outer layer of the fruits of sample No. 3 was much less than the corresponding figures for samples Nos. 1 and 2.

The fat obtained in all three cases had a dark greenish colour which was almost completely removed by treatment with animal charcoal, and the fat was then of a pale greenish-yellow tint. An examination of the fat obtained from the fibrous layers in samples 1 and 2 and decolorised with animal charcoal gave the following results, compared with the range of the principal constants recorded for commercial palm oil:

	Sample 1.	Sample 2.	Commercial palm oil.
Specific gravity at $\frac{100° C.}{15·5° C.}$	0·848	0·855	0·9209–0·9245
Acid value [1]	162·0	121·3	—
Saponification value [1]	197·4	203·1	196·3–205·5
Iodine value . . *per cent.*	75·1	65·4	53–57·4
Titer test [2]	31·0° C.	—	35·8° C.–46·4° C. (mostly 44·5° C.–45° C.)
Hehner value [3]	97·0	—	94·2–97
Reichert-Meissl value [4]	1·65	—	0·86–1·87
Unsaponifiable matter, *per cent.*	0·95	—	—

[1] *Milligrams of potash for* 1 *gram of fat.* [2] *Solidifying point of fatty acids.*

[3] *Percentage of insoluble fatty acids and unsaponifiable matter.*

[4] *Cubic centimetres of decinormal alkali required to neutralise the soluble volatile acid from* 5 *grams of fat.*

Owing to the bulky and fibrous nature of the outer layer of the nuts, the fat could probably not be obtained by expression, but would have to be extracted by means of solvents; and this process would most likely be unremunerative, especially as the residual fibre would be of little or no value.

Kernels.—The kernels yielded a solid, white, crystalline fat, resembling coconut oil in appearance and smell. The percentages of fat and moisture found in the kernels from the samples of fruits Nos. 1, 2, and 3, and in the samples of kernels Nos. 4 and 5, are given in the following table:

	No. 1. *Per cent.*	No. 2. *Per cent.*	No. 3. *Per cent.*	No. 4. *Per cent.*	No. 5. *Per cent.*
Moisture	4·6	4·3	4·2	4·2	4·9
Fat	67·7	68·4	71·6	68·5	65·4

An examination of the fats obtained from these five samples of kernels gave the following results:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Specific gravity at $\frac{100° C.}{15·5° C.}$	0·870	0·871	0·871	0·868	0·870
Acid value [1]	3·5	13·1	1·2	20·4	12·3
Saponification value [1]	255·0	256·5	256·5	252·4	252·4
Iodine value . . *per cent.*	13·6	13·7	11·4	13·7	11·0
Titer test [1]	19·8° C.	21·0° C.	20·2° C.	19·7° C.	—
Hehner value [1]	—	—	—	87·7	—
Reichert-Meissl value [1]	6·8	8·3	8·2	7·1	—
Polenske value [2]	—	15·4	—	12·5	—
Unsaponifiable matter, *per cent.*	0·24	0·28	0·23	0·28	—

[1] *For the meaning of these terms see p.* 239.

[2] *Cubic centimetres of decinormal alkali required to neutralise insoluble volatile acid from* 5 *grams of fat.*

For the purpose of comparison a table showing the range of the principal constants of coconut oil and palm-kernel oil is given below:

	Coconut oil from copra.	Palm-kernel oil.
Specific gravity at $\frac{100° C.}{15·5° C.}$	0·874	0·873
Iodine value . . *per cent.*	8·0–10·0	10·3–17·5
Saponification value	246–268	242·4–254·8
Titer test	21·2°–25·2° C.	20·0°–25·5° C.
Hehner value	82·4–90·5	91·1
Reichert-Meissl value	6·65–7·5	5·0–6·8
Polenske value	18·0	—
Yield of oil from kernels	64·5–74·7	46·7–52·5

The foregoing tables indicate that cohune kernel fat resembles very closely both coconut oil and palm-kernel oil, but is generally of somewhat softer consistency.

Residual Meal.—A sample of the residual meal left after the extraction of the oil from the kernels was examined, and its composition found to be as follows, compared with that of coconut cake and palm-kernel meal (see Kellner, *The Scientific Feeding of Animals*, p. 377); in each case the figures have been re-calculated on a basis of 10 per cent. of fat.

	Cohune nut kernel meal.	Coconut cake.	Palm-kernel meal.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	9·2	10·3	10·0
Crude proteins	21·7	21·0	17·1
Consisting of:			
True proteins	20·3	—	—
Other nitrogenous substances	1·4	—	—
Fat	10·0	10·0	10·0
Starch, etc.	38·8	38·1	35·7
Fibre	15·6	14·5	23·2
Ash	4·7	6·1	4·0
Nutrient ratio [1]	1 : 2·9	1 : 2·9	1 : 3·4
Food units [2]	118	115·6	103·5

[1] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.*

[2] *The total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins.*

The meal contained no alkaloids or cyanogenetic glucosides.

It will be seen from the above table that the composition of cohune nut kernel meal, calculated on a basis of 10 per cent. of fat, is practically identical with that of coconut cake. Compared with palm-kernel meal the present sample contains a higher percentage of protein and less fibre. Feeding trials with the meal would be necessary, however, to determine the real value of the meal for feeding purposes and to ascertain whether or not it can safely be used as a general feeding stuff for animals.

As already mentioned, the fibrous layer of the cohune fruit is not likely to be of value under present conditions

for the fat it contains. If, however, at some future time plant for the extraction of fat from cohune kernels by solvents were installed in British Honduras, the question of recovering the fat from the fibrous layer of the fruit would be worth consideration.

The cohune kernels yield about the same percentage of fat as copra, and rather more than palm kernels. If shipped to Europe in commercial quantities and in good condition, they should therefore realise prices approximating to those of copra. The present prices of copra in the United Kingdom are approximately from £23 10*s.* to £24 17*s.* 6*d.* per ton (June 1913).

The cohune kernel fat should be worth about the same price as palm-kernel oil or coconut oil, the present values of which in the United Kingdom are as follows: coconut oil from £40 to £50 per ton, and palm-kernel oil about £37 10*s.* per ton (June 1913). It is not possible, however, to give a definite commercial valuation of cohune kernel fat until it has been submitted to technical trial on a large scale.

SPECIAL ARTICLE

COFFEE CULTIVATION IN UGANDA

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Coffee is the staple crop of European planters in Uganda. Six years ago the amount exported was only 194 cwts., valued at £194; but during 1912–13 the amount rose to 3,336 cwts. and value to £8,940. The area under coffee at the end of March 1913 was 4,568 acres, and under coffee and rubber 2,659 acres. In spite of the rapid progress thus made the area under coffee is still being extended, and the value of the exports during the nine months ended December 31, 1913, was £16,852. This large increase is due to coffee estates coming into bearing for the first time during 1913. Other estates have not yet begun to bear, so that a further large increase in the amount and value of coffee

exported may be confidently looked for in each of the next few years.

It is a question whether the maximum output, when once attained, will be maintained over a large number of years. Among the factors governing the future of the industry the chief will be the prevalence or scarcity of diseases and pests, and the amount of success achieved with other Uganda crops, such as cocoa and rubber. Cotton growing is almost entirely in native hands, and is not in favour with European planters; at present the possibility of Uganda following the example of Nyasaland, and making a success of cotton planting under European management, seems remote.

Varieties of Coffee in Uganda

The indigenous coffee of Uganda is *Coffea robusta*. It occurs throughout the Kingdom of Buganda and certain other parts singly or in groups of from three to twelve trees, and though, to all appearances, it grows well and bears heavy crops, it is capable of improvement by good cultivation. These indigenous trees are usually heavily shaded by bananas, bark-cloth trees, and the like, and leaf disease (*Hemileia vastatrix*, B. and Br.) is rife. The native owner pays no attention to the trees beyond picking the ripe berries. The produce is consumed locally. This "native" coffee was grown originally in specially cleared strips of forest, and the largest output came from the Sese Islands, a group in Lake Victoria (Victoria Nyanza), visible on the horizon from the shores of the Kingdom of Buganda. It was only when the natives realised that this coffee was of economic value that they planted it in their own gardens, as it is found at the present day.

The coffee cultivated by Europeans in Uganda is of two kinds—"Nyasaland" and "Bourbon." It is said that the "Bourbon" sort came from Aden, *via* the Île de Bourbon, to East Africa, transported thence by French missionaries, and that the "Nyasaland" coffee was derived from the "Blue Mountain" coffee of Jamaica, introduced into Nyasaland and thence into Uganda some dozen years ago. If

credence can be given to these statements, both these coffees are to be regarded as derived from *Coffea arabica*, L.

Little care has been taken as regards seed-selection; much inferior seed has been planted, and in some areas inequalities of growth are very noticeable. The demand for seed, caused by the recent opening-up of new land, was met by local supplies from the older plantations, particularly from those in the hands of the missionaries, who did valuable pioneering work. Both "Bourbon" and "Nyasaland" sorts of coffee thrive well in Uganda, and give heavy crops in the fourth year.

The outbreak of coffee-leaf disease at the end of 1912, and the epidemic during the rainy season, March–May of 1913, led planters to give some attention to other kinds of coffee. *C. liberica*, Hiern, is not immune to leaf disease, and it is doubtful whether it will thrive in Uganda. Its product is inferior to that of Arabian coffee. Moreover, it requires a rich soil, a hot, moist atmosphere, and a lower elevation than that obtaining in this country. Plants of *C. liberica* and *C. stenophylla*, G. Don, are being raised by the Department of Agriculture from seed imported from West Africa, and their progress will be watched with interest. A few acres have been planted with *C. robusta*; but enthusiasm for it is lacking, and it is very unlikely that it will ever become a favourite crop.

Climate, Soil, and Situation

The Uganda Protectorate is situated within the zone usually regarded as providing the best conditions for coffee-culture. The climate and soil are matters of primary importance, and in both of these respects the conditions in Uganda are favourable. There is much rich, deep soil of free texture which is very suitable for coffee. Potash is an essential constituent of a good coffee soil, and it is present where forest has been felled, or where the grass-land, so common in this Protectorate, has been cleared. Coffee land should be well drained, and stagnation of soil-water is as undesirable for coffee as is a stiff clay subsoil. The contours of the planting districts in Uganda favour easy drainage, for gentle slopes are more usual than steep

declivities, and flat, swampy land can always be avoided. Similarly, the intending planter should keep clear of excessively humid or excessively dry areas. A long, dry season is very trying to coffee plants, and a wet atmosphere, due to excessive rainfall or the nearness of marshy places, results in the production of luxurious growths of wood and foliage, to the detriment of the crop. Well-established coffee, however, does stand a considerable degree of heat, so long as it has sufficient moisture. It must be remembered also that a sufficient elevation will render temperate a region which is situated on the Equator itself. This is often the case in Uganda, and, on the whole, the climate, elevation, and general conditions are eminently suitable for coffee cultivation.

As has been said, gradual slopes are a feature of the areas already devoted to coffee-planting in Uganda. The most suitable areas are those which are free from sour material and possess sufficient incline not to retain an excess of moisture, and are yet not steep enough to allow heavy rain to denude the land of its valuable surface soil. In many cases the action of natural forces has formed at the base of a slope, or on its lower parts, an accumulation of soil which is permanent, and contains much organic matter produced by the decay of vegetation from the surrounding hills.

Heavy forest land is not usual in the planting districts, but where it does occur—for example, in occasional patches in hollows—it can be thinned and retained as a field or nursery shade. Most of the land acquired for coffee estates bears "elephant grass" (*Pennisetum purpureum*, Schum.), which grows thickly, and often to a height of over 12–15 ft. The clearing of such land consists in cutting and burning the grass, turning over the soil to expose and kill the grass-roots, and finally, removal of the debris.

Manures

It is unlikely that the good coffee land of Uganda will require to be manured for some years to come for the sole purpose of supplying to an exhausted soil the elements it requires. In parts, trees suffer because of denudation of slopes, and in such cases the application

of manure, combined with efforts to replace lost soil and to prevent further loss, is effective. At present all that is needed in the Uganda plantations is that treatment should aim at providing the trees at the proper time with such a stimulus as will enable them to carry through the wet season, with its dangers of the spread of *Hemileia* disease, and through the dry season, with its dangers of drought and defoliation. Animal dung is so scarce as to be negligible as a manure, and the price of artificial manures is prohibitive. Planters are therefore compelled to use green manures and vegetable refuse such as coffee pulp. Mulching could be advantageously practised to a much greater extent than is yet the case.

Sowing and Planting

For sowing purposes, only the largest and finest fruits from the healthiest trees should be chosen. After hand-pulping and sun-drying the seeds are sown in rows in beds laid down on gently-sloping virgin soil, which has been thoroughly dug and prepared. Sowing by scattering has been practised, but this method leads to a waste of seed and of space. Coffee seedlings have been raised without shade or watering, but it is more usual to have them shaded and watered, and to harden them off, as the time for planting-out comes on, by removing the shade and reducing the water supply. Sowing at stake has not been tried; it avoids the risk and expense of transplanting, but it exposes the young plants to the dangers of heat and drought, and is expensive because of the necessity for continued clean-weeding. Blanks are supplied by potted plants from the nursery.

Lining presents no difficulties except those due to unevenness of ground. The size of the holes varies with the soil. Some planters standardise their holing by using a kerosene tin, fitted with a handle for convenience, as a gauge of size, the hole being made large enough to allow of the tin being turned round in it.

Planting-out is a critical operation, but the planter who organises his labour for the various parts of the

process and endeavours to make his men realise the importance of their work, will have few losses, provided that he is fairly fortunate in weather conditions. A little temporary shade is always advisable for newly planted coffee. It is usually made with the leaves of a palm, *Phœnix reclinata*, Jacq. (native name " nkindu ").

Planting distances should vary according to the quality of the soil, the exposure, and the presence or absence of insect pests and fungoid diseases. Allowance should be made for growth and facility of cultural and other operations. Planting has been too close in several cases. The presence of coffee-leaf disease and the consequent necessity for spraying operations have modified opinion to some extent, and, although 8 × 6 ft. is a favourite spacing, it seems best to plant at least 8 × 8 ft. as a general rule. Triangular planting is rarely found in Uganda. Its advantages are purely theoretical, and the arrangement interferes with inspection and the apportionment of tasks.

Shade Trees and Wind Belts

The question of permanent shade for coffee in Uganda is an unsettled one. Perhaps it is more correct to say that the coffee-growing industry of the country is yet too young to allow of any definite deduction from experience as to whether shade is necessary or unnecessary. Shading has not been given a fair trial, though a few experiments have been made. The results of these were, on the whole, unsatisfactory, possibly because the shade was of too heavy a nature and of such materials as inhibited the circulation of air about the plants, particularly during the night, when the atmosphere is apt to be moist. Shade is advisable on slopes where heavy tropical rains cause erosion and denudation, and it would prove advantageous on wet soils. Its cover aids decay of vegetable matter on the surface, and leguminous shade trees enrich the soil. On the other hand, shade is conducive to a diminished yield and to dampness, and in order to be a protection against infection by *Hemileia* disease by wind-borne spores, it would

require to be so heavy as to interfere seriously with yield and with the movement of the air. It cannot be regarded as a direct protection against *Hemileia* infection; its benefits in this respect are indirect in so far as its presence will induce a vigorous condition of the shaded plant. Further, shade requires to be carefully regulated, and the expense entailed would probably be out of proportion to the benefits afforded. On the whole, lack of experience precludes the statement of a definite opinion at this stage, but it is strongly felt that shade for Uganda coffee is worth an extended trial. The silky oak, *Grevillea robusta*, A. Cunn., is being experimented with for this purpose, and various species of leguminous trees would be suitable. Para rubber trees are used as shade on several estates. They have the advantage of being profitable and the disadvantage of being subject to a root disease (*Hymenochæte noxia*, Berk.) which occurs also on coffee. Cases of this disease have occurred in Uganda, but not frequently, on both coffee and *Hevea*.

Owing to the situation of Uganda, the question of exposure to sunshine is a simpler one than that of exposure to winds. The latter demands consideration. In parts, *e.g.* those near Lake Victoria, strong, steady winds occur at certain times. In some cases they have blasted the exposed trees on one side, and even so loosened them in the soil as to cause eventual death. Remedial measures, however, can be adopted in such cases.

There is no lack of suitable trees for either a high or low wind-belt. Bananas are extensively used. They grow thickly, and they provide food for the native labour staff. Only one indigenous tree (*Dolichandrone platycalyx*, Baker), occasionally used in this connection, is known to harbour coffee pests.

Weeding and Cover Crops

In several cases weeding has proved an expensive item in estate management. Conditions very often favour the rapid growth of weeds, and lead to their becoming a more or less temporary menace to coffee cultivation, but the

real source of expense and trouble lies in the lack of thorough initial clearing and the continuance of operations on scientific lines. Hand-weeding with forks is the most efficient method of procedure. Cover-crops are not much in favour. The remarks made concerning shade apply to cover-crops, and the Department of Agriculture is making trials with various plants.

Pruning

Good pruning enables the trees to bear better crops, and tends to lessen the dangers and effects of leaf disease. Unpruned trees become thickly-entangled masses of branches and leaves, and the chambers so formed about the trunks are a series of forcing-houses for the development of *Hemileia* spores. The planter should never be afraid of sacrificing a portion of his crop. By pruning he will strengthen his trees, prolong their lives, and ease the labours of subsequent years. The difficulties in the way of accomplishing the pruning of a large estate are great. Chief among them are expense and labour, but that they are not insurmountable has been proved.

Pests and Diseases

The "Bourbon" and "Nyasaland" varieties of coffee are, unfortunately, rather susceptible to *Hemileia* disease. The recent virulence of the attack may be explained on the assumption that the parasite, endemic in the country, suddenly found itself in the midst of a generous supply of fresh hosts owing to the rapid planting-up of large areas of coffee. Its attack was able to assume epidemic proportions unchecked. Despite the prevalence of this disease, the outlook is favourable, for the indications are that its virulence will be less in the future than in the past. Planters are recognising that much depends on their efforts to eradicate it, and the Department of Agriculture is alive to the situation. The fungus, being endemic in Uganda, cannot be expected to work the havoc that it has wrought in other countries into which it was introduced.

Exterminators have been used with success in dealing

with those common tropical pests "white ants" (*Termites*). Their ravages are much greater in certain districts than in others, while, in some parts, they have caused little or no damage to growing plants. Their presence is a danger, the gravity of which is not recognised by all concerned, and against which provision should be made.

Harvesting and Preparation of the Berries

Native labourers can pick the coffee crop efficiently after a little instruction, and many estates are now erecting machinery for pulping and drying coffee. Fermentation is done in tanks, and the first part of the drying process is accomplished by spreading the beans on wire trays in the sun. Climatic conditions often interfere with the sun-drying process, for harvesting takes place during the wet season. A hulling and sizing factory is about to be established in Kampala, the commercial capital of Uganda. Such work is best left to those who make a speciality of it.

Good prices have been obtained under conditions far from perfect, and the gathering of experience and subsequent improvements in methods should in time raise the standard of quality of Uganda coffee. In the meantime, the prospects of the industry cannot be regarded as other than bright.

[*Note by Editor.*—In view of the promising condition of coffee cultivation in Uganda described by Mr. Small, reference may be made to a report on plantation coffees from Uganda published in this Bulletin two years ago (1912, **10**, 397). The results of the examination of these coffees in the Scientific and Technical Department of the Imperial Institute showed that they were of very promising quality, being valued at 70*s*. to 72*s*. per cwt., with Nyasaland coffee at 76*s*. to 82*s*., and Central American coffees at 77*s*. to 85*s*.

Such defects as the Uganda coffees exhibited were those due to inexperience in preparing the beans for the market. Recommendations for avoiding these defects were made, and it was pointed out that with more experience an excellent quality of coffee should be produced by the Uganda planters.]

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

THE UTILISATION OF FISH AND MARINE ANIMALS AS SOURCES OF OIL AND MANURE.

PART I.—OILS.

ALTHOUGH fish of many kinds have been used as manure since early times, the industrial manufacture of fish oil and fish manure is comparatively modern. Whaling and the manufacture of whale oil, however, have been carried on for many centuries.

The development of the fish manure industry is due to a variety of causes, such as (1) the utilisation of edible fish when the supply exceeds the demand; (2) the utilisation of inedible fish; (3) the disposal of fish waste, such as livers, heads, and offal obtained as waste products in the canning, drying, and curing of fish.

The fish oil industry has arisen as an offshoot of fish manure manufacture, owing to the necessity for eliminating oil and water so that the fish may be obtained in a dry, non-putrescible form suitable for storage and subsequent use as manure.

FISH OILS

Roughly speaking, the flesh of fish having livers rich in oil, *e.g.* cod, is almost devoid of oil; whilst fish with oily flesh possess livers which only contain a small amount of oil. The oils obtained from fish may consequently be divided into (1) *Fish-liver oils*, the most important being cod-liver oil, and (2) *Fish-body oils*, of which menhaden and herring oils are produced in large quantities.

The preparation of either of these two classes of oil can be effected by several means; the oldest method is to allow the tissues to ferment in masses, when the oil exudes and can be collected. This is a crude method, which has been used from the earliest times; a variety of devices being employed to facilitate the separation of the oil. An improvement on this method is to boil the fresh fish with water in pans over a fire, when the oil rises to the top

and can be skimmed off; it is advisable also to submit the residual boiled fish to pressure in order to obtain a good yield of oil and a pressed product suitable for use as manure, and free from any large quantity of oil. This can be effected by small hand-screw presses.

It is difficult to produce a high-grade oil of uniform quality by such means, as the process is slow, and the fish is liable to deteriorate before use. Further, the use of fire-heated pans may cause charring with the production of a dark-coloured oil; but this can be obviated by the use of water or steam-jacketed pans or of live steam. The crude oil produced is admixed with water containing soluble matter ("glue"), and is separated by decantation, boiling, and filtration.

Such methods as these are only suitable for use on a comparatively small scale, and have been replaced by large modern machinery in the menhaden oil and similar industries; but they are still useful in localities where small and intermittent supplies of fish are available, or where labour is cheap.

Modern factory methods of preparing fish oils are described under cod-liver oil (p. 255), and will be considered further in the later part of this article dealing with fish manures. Extraction of dried fish by volatile solvents such as light petroleum is also employed to some extent for the preparation of oil (Lewkowitsch, *Chemical Technology and Analysis of Oils, Fats, and Waxes*, London, 1909, ii., 337).

Composition and Uses of Fish Oils

Fish oils, like vegetable oils, consist of glycerides of fatty acids, and, like them, are employed in soap and glycerin manufacture; fish oil "stearins" of pale colour can be used in the manufacture of soap of fair quality, while the lower grades of fish oils can be used directly for making soft soap, or, after hardening by "hydrogenation" (see this BULLETIN, 1913, 11, 660), for hard soaps. Most fish oils readily absorb oxygen from the air, as is indicated by their high iodine value, but they do not dry so rapidly as linseed oil, and do not yield as a rule sufficiently tough or

transparent films to render them suitable for paint manufacture. Some fish oils can be used, however, in admixture with linseed oil for paint manufacture. The fact that fish oils absorb oxygen readily and become gummy renders them unsuitable for lubricating purposes. They are still used to some extent as illuminants.

Fish and fish-liver oils are largely used in the leather trades for the manufacture of chamois leather and for dressing and currying leather, with the object of rendering it soft, supple, and waterproof. For these purposes emulsions of the oils are prepared with soap solution, egg yolk, etc. These mixtures are applied to the leather either in a dry or moist condition by hand or by mechanical means. Chamois or "wash" leather is leather prepared solely by means of oil, generally cod-liver oil. In the manufacture of chamois leather the delimed skin, usually split sheepskin, is treated with cod-liver or other fish oil and either packed in boxes and allowed to heat owing to spontaneous oxidation of the oil, or hung in warm stoves, the oiling and oxidation being repeated until the skin is sufficiently "tanned." The excess of oil is removed from the skin either by dipping in hot water and pressing, when the oil which exudes is termed "dégras" or "moellon," or by treatment with potash or soda solutions, in which case the oil is recovered by means of acids, and is termed "sod" oil. Both "dégras" and "sod" oils are used over again in leather dressing; in fact, the demand for the former is so great that some factories carry out "chamoising" solely for the purpose of obtaining it, the skins being oiled and oxidised over and over again until worn out. Fish oils are also employed in tempering steel. Large quantities of certain oils are employed for "batching" jute and other fibres. The process of batching consists in treating the fibre before spinning with mixtures of fatty and hydrocarbon oils, soap, and water, the object being to render the fibre soft, supple, and suitable for spinning. Whale oil is largely used for this purpose, but fish oils are also employed.

The possibility of using fish oils for food purposes depends on the removal of the fishy taste and smell. The

solution of this problem has often been attempted, and is the subject of many patents. It seems probable that the recently introduced process of hardening liquid oils by hydrogenation (*loc. cit.*) may prove effective, as it is stated (*Journ. Soc. Chem.-Ind.*, 1912, **31**, 1165) that the odour of fish and whale oils may be completely removed by this means.

Cod-liver Oil

The preparation of oil from the livers of the codfish (*Gadus morrhua*) was a natural result of the necessity for finding some use for the large quantities of livers obtained as a by-product of the salted and dried codfish trade. The shoals of cod frequent the northern seas, principally around the coasts of Norway, the British Isles, and the northern coasts of North America. The principal centres of the cod-liver oil industry are Norway and Newfoundland, while more recently the cod fishery has assumed importance on the Alaska coast, and has also been undertaken by the Japanese in the Sea of Okhotsk. In Norway the fishing season at the Lofoten Islands, where the finest medicinal oil is manufactured, takes place during the early part of the year, while the fish appear farther north, at Finmarken, in June. The fish are caught either by hook and line or by trap-nets, a method used to great advantage in the narrow fiords.

Cod-liver oil was at first produced by extremely crude methods, such as piling the livers in heaps or in barrels, and collecting the oil which exuded as the livers underwent decomposition. The first portion of oil obtained by this means was of pale colour, and not very unpleasant in odour or taste, but the later portions became increasingly dark in colour and offensive in smell. Consequently several grades of oil were produced which do not appear on the market now, owing to improved methods of manufacture.

At the present time cod-liver oil may be roughly divided into three classes: (1) medicinal cod-liver oil; (2) cod oil (cod-liver oil for technical use); and (3) "coast cod oil," prepared from cod livers admixed with livers of other fish. Medicinal cod-liver oil is prepared chiefly in the Lofoten Islands, Norway, from the livers of cod

brought by steam trawlers to the shore factories as soon as possible after the fish are caught. On arrival at the factory the fish are cleaned, and the livers removed and sorted, any damaged or diseased livers being rejected. The livers are then placed in tin-lined vessels heated by live steam or by steam-jackets. Under these conditions the cells of the liver are broken up, and the oil, which separates rapidly, is run off. Plant for treating the livers on board the trawlers immediately the fish are caught has been devised, and appears to be used to some extent where the fishing-grounds are far from shore.

The livers contain about 50 per cent. of oil, but the yield of oil varies considerably with the condition of the fish from year to year, with consequent fluctuations in the market prices of the oil. The following table shows the variations in the annual output of oil from Norway compared with the number of cod caught (*Ann. Rept. Marine and Fisheries, Newfoundland*, 1912, Appendix, p. 56):

Year.	Cod.	Oil.	Average price of oil, f.o.b. Norway.
	Millions.	*Barrels.*	*Per barrel.*
1902	45	22,500	£7 4*s.*
1903	48	2,800	£24 13*s.*
1911	64	43,300	£5 7*s.*
1912	99	76,200	£2 18*s.*

This crude oil is purified by filtration, and bleached by means of fuller's earth, or by exposure to light in closed vessels. The stearin, which would cause the oil to congeal at winter temperatures, is removed by freezing the oil and filtering, and is sold as fish stearin for soap-making.

The unsound or tainted livers which have been sorted out are worked up by similar processes, and yield a lower grade of darker-coloured oil, which is sold usually under the name "cod oil," and is used for technical purposes; the quality of such oil is superior to that formerly produced on account of the improved methods of manufacture, and the fresher state in which the livers reach the factory, owing to the use of steam trawlers.

The name "coast cod oil" is applied to oil prepared from the livers of cod mixed with those of other fish, such

as hake (*Merluccius vulgaris*), haddock (*Gadus æglefinus*), coal fish (*Gadus* sp.), etc.; this oil is also used for various technical purposes.

Large quantities of cod-liver oil are produced in Newfoundland, and although modern machinery and methods similar to those employed in the Lofoten Islands have been introduced, and high-grade medicinal cod-liver oil has been prepared, it appears that the higher price obtained for such oil is not sufficient to warrant the extra trouble necessary, and that only oils for technical use are now being produced in large quantity.

Pure medicinal cod-liver oil is a pale yellow liquid oil, with a slight fishy odour, and a not unpleasant taste; it has the following constants (Lewkowitsch, *Chemical Technology and Analysis of Oils, Fats, and Waxes*, 1909, ii., 354).

Specific gravity at $\frac{15° C.}{15° C.}$		0·922–0·927
Saponification value		182–187
Iodine value	*per cent.*	159

The constants of the technical grades of cod-liver oil vary somewhat according to the methods employed in manufacture, the amount of stearin removed, etc.

The high prices which have sometimes prevailed for medicinal cod-liver oil have rendered it liable to adulteration with other fish-liver oils, fish oils, and whale oils, the detection of which is difficult, and often impossible; but such adulteration is infrequent under present conditions.

The present price of medicinal cod-liver oil is about 100*s*. per barrel in London, while Newfoundland cod-oil is valued at £22 per ton in Glasgow, and "Pure East Coast" oil at £16 15*s*. per ton in Hull.

In 1911–12, 2,578 tons of cod oil, valued at £58,896, were exported from Newfoundland, and in addition 51,227 gallons of refined oil, valued at £8,695, were also exported. The amounts and values of steam-refined cod-liver oil exported from Norway during recent years are as follows:

	1910.	1911.	1912.
Quantity, tons	4,063	4,143	6,554
Value, £	187,478	206,267	206,922

Other Fish-liver Oils

Among the other fish-liver oils of commerce are dog fish, shark, and skate liver oils. In many cases the livers of such fish are not kept separate from the cod livers, but are used together for the manufacture of "coast cod oil" (see p. 255). Dog fish are of particular importance in this connection on account of the damage which they cause by eating valuable edible fish, driving the shoals from fishing grounds, and breaking nets and lines (*Document* No. 622, 1906, p. 40, *U.S. Bureau of Fisheries*). The flesh of dog fish is eaten frequently in some localities, but a prejudice appears to exist against it, and the dog fish caught are not used to any considerable extent for food. Consequently, although they are not so prolific as most fish, producing not more than fifteen young in a season, they have increased in number to such an extent in some localities as to menace the fisheries seriously.

The oils derived from the livers of shark, skate, and dog fish are very similar to cod-liver oil, and are used as adulterants of, or substitutes for, cod-liver oil for technical purposes.

Sharks of various kinds are found all over the world, but the sleeper shark appears to be the species most commonly killed for the production of oil, the most important fishery being that off the coast of Norway, while this species is also killed off the coasts of Iceland and other countries for the sake of the oil (*Rept. of Commissioner, U.S. Commission of Fish and Fisheries for* 1902, p. 227). It is a large fish, measuring up to 25 ft. in length, and when taken in the autumn yields 12 to 50 gallons of oil.

A larger species, the basking shark, is said to yield from 80 to 200 gallons or even more oil.

Experiments have been made recently in Malaya in the production of oil from the livers of sharks which come into the lagoons to pair, when they can be easily speared there; a shark 11 ft. in length yields about 15 gallons of oil (*Journ. Roy. Soc. Arts*, 1912, **60**, 692).

Menhaden Oil

The menhaden (*Brevoortia tyrannus*) is a fish of the herring family or *Clupeidæ*, and frequents the Atlantic coast of the United States from Texas to Cape Cod. Although the flesh is not of unpleasant taste, the species has many bones, and is not used as food to any appreciable extent. Menhaden and similar fish have been used as manure for many years in America, but no appreciable quantity of menhaden oil appeared on the market till about 1860. Since that time the production has increased enormously, and some forty factories are now in existence. The menhaden appears off the coast about April, and in northern waters the fishing season lasts till November; in the Southern States the fishing commences a little earlier, and lasts till the end of December. Catches of fish in southern waters in mid-season are small, most of the fish being taken during the spring and autumn. The fishing is now carried on principally by means of fair-sized steamers carrying crews of about fifty men, or by sailing vessels with auxiliary engines, most of the fish being caught within three miles of shore by means of "purse seines." The method of catching the fish is to surround the shoal with the net, which is thrown out from two boats rowed round the shoal. The nets are about 1,500 ft. long and 180 ft. deep, supported by a row of cork floats at the top, and fitted at the bottom with rings carrying ropes. The rings serve as weights, and also cause the net to form a bag, preventing the escape of the fish when the ropes are hauled tight. When captured the fish are transferred from the net to the ship's hold by means of large dip nets operated by block and tackle.

The larger steamers have a capacity for 750,000 fish (about 220 tons), sailing vessels with auxiliary engines for about 250,000 fish. The fish caught in this way consist almost entirely of menhaden; any edible fish is used by the crew as food, but the quantity obtained is not large as a rule, although sometimes herring and other fish are caught in quantities. Most of the factories now handle the fish by means of automatic elevators and use machinery for cooking

the fish and expressing the oil. Although very large quantities of oil are produced, the manure is of first importance in the menhaden industry, and therefore the methods of obtaining the oil will be dealt with fully in a later portion of this article dealing with the manufacture of fish manure.

The yield of oil obtainable from menhaden varies considerably from year to year, and also with the time of the year; thus the fish often yield little or no oil in the spring, while those caught towards the end of the season yield on an average about 12 gallons, and frequently 15 gallons per thousand. The yield of oil also varies with the locality where the fish are caught, for instance, in 1900 the following yields were obtained:

	Gallons of oil per 1,000 fish.
Rhode Island factories	5·76
New York "	6·39
Delaware "	4·92
Texas "	3·51

The crude menhaden oil produced at the factories varies in colour from light amber to dark brown according to the method of preparation and preliminary purification, and is subjected to the usual processes of separation of stearin, clarification, and decolorisation. When carefully manufactured it is a clear bright oil and should be comparatively odourless and tasteless. It has the following constants (Lewkowitsch, *loc. cit.* p. 340.)

Specific gravity at $\frac{15^\circ \text{C.}}{15^\circ \text{C.}}$		0·927–0·933
Saponification value		188·7–193
Iodine value	*per cent.*	139·2–172·6

The use of menhaden oil for paint appears to be on the increase in the United States, and according to Toch (*Journ. Indust. and Eng. Chem.*, 1911, **3**, 627), it is the best fish oil for this purpose, as up to 75 per cent. can be used in admixture with linseed oil, the paint still standing exposure to air well. Its use for painting interiors of buildings is not advisable on account of the unpleasant smell. It is also claimed that paint made with menhaden oil is more resistant to heat than linseed oil paint, and

is therefore suitable for use on boilers and chimneys. It can also be used in printing ink manufacture, and according to Toch (*loc. cit.*) it is more flexible and less liable to crack than linseed oil, so that it can be used for patent leather manufacture, although it produces a peculiar efflorescence when used for this purpose. The most suitable "drier" for use with menhaden oil paints is stated to be a tungate drier (see this BULLETIN, 1913, **11**, 456).

The price of menhaden oil has fluctuated considerably owing to over-production and to other causes, having been as low as 8½*d.* per gallon at one time; recently the prices were 1*s.* 1½*d.* to 1*s.* 2*d.* per gallon for "Northern Crude" and 1*s.* 5½*d.* to 1*s.* 6½*d.* for "White-bleached Winter" oil (*Oil, Paint and Drug Rep.*, June 1913).

Some idea of the great importance of the menhaden oil industry is afforded by the following statistics (*American Fertilizer Handbook*, 1913, p. 68), showing the total production in recent years in the United States:

	1910.	1911.	1912.
Barrels of oil	70,000	135,000	131,089

The average quantity of fish caught during the last thirty years is about 500 million per annum (*Journ. Indust. and Eng. Chem.*, 1913, **5**, 379).

Other Fish Oils

Although the menhaden is probably the only fish which is caught on a large scale solely for the manufacture of oil and manure, enormous quantities of oil and manure are produced from other fish, such as herrings, when these are plentiful.

The herring (*Clupea harengus*), and the related species, sardine, pilchard, sprat, and anchovy, are probably the most important products of the world's fisheries, on account of the large quantities caught for food. As the oil is prepared from the surplus fish, not required for food, and from waste fish, the yearly production of oil varies considerably. Large quantities of herring oil (and manure) are manufactured in Norway and Sweden, where the utilisation of herrings for this purpose has long been

known; over a century ago the Bohuslan fisheries of Sweden produced between one and two million gallons of oil annually (*Report of Commissioner: U.S. Commission of Fish and Fisheries for* 1902, p. 236). The herring is a fish of wide distribution, and herring oil is consequently produced to some extent in all the maritime countries of Europe, on the Atlantic and Pacific coasts of North America, in Japan and elsewhere.

In Japan large quantities of fish oil are produced and exported under the name of "Japanese fish oil." The oil appears to be derived chiefly from a species of herring (*Clupea pallasi*) called the "iwashi," and also from sardines and other fish. It has been produced for many years by primitive processes, but improved methods of manufacture are now being employed.

Sardine oil is prepared from the heads, viscera, etc., and from waste fish from the sardine preserving industry. The Madras Fisheries Department has been engaged in recent years in developing the sardine fishery in the neighbourhood of Cannanore, together with the production of oil and manure; an account of the work done in Madras, together with results of analysis of a number of samples of the oil and manure carried out at the Imperial Institute, have been given in this BULLETIN (1914, **12**, 50).

Salmon oil is produced as a by-product of the salmon canning industry of British Columbia, and according to Lewkowitsch large quantities are exported to the United Kingdom for use in the leather industry, but the quantity of salmon oil exported is not given in the official statistics. The oil appears to be derived chiefly from the heads of fish, as the viscera do not contain sufficient oil to render extraction profitable.

In the United States of America halibut heads are also used as a source of oil.

The following table shows the quantities and values of fish and marine animal oils of all kinds exported from Norway during recent years.

	1910.	1911.	1912.
Quantity, metric tons	14,745	24,594	39,139
Value, £	427,772	662,617	781,228

The quantities and values of fish oil exported from Japan during recent years are given in the following table:

	1910.	1911.	1912.
Quantity, tons	17,872	11,588	15,030
Value, £	268,900	187,400	222,100

Marine Animal Oils

The most important oils derived from marine animals are those obtained from the many different kinds of whales and seals; of less importance are the oils derived from dolphins, porpoises, and other aquatic mammals.

Whale Oil

The capture of whales in northern seas was carried on by Norwegians many centuries ago, while the whaling industry of the Basque provinces and Spain, which was important from the tenth to the sixteenth century, was prosecuted so vigorously that the species of whale utilised became almost extinct. In the earlier part of last century whale oils were used for lighting, lubricating, and other purposes to a very large extent, and the large demand for oil led to a scarcity of whales. The substitution of vegetable oils and petroleum for whale oil then led to a falling off in the demand for whale oil, and the industry diminished in importance. The high prices in whalebone, the present large demand for oils of every kind, together with improved methods of whaling and the discovery of new whaling grounds, have however rendered whaling a profitable industry in several parts of the world during recent years. The most valuable part of the whale is the blubber, which is a layer of fat covering the body and lying between the skin and the flesh, and in the larger whales varies in thickness from about 1 in. to as much as 22 in., according to the species, size, and condition of the whale, and contains about 75 per cent. by weight of oil. The blubber of right whales is usually thicker than that of the sperm whale, while that of the smaller whales, such as orcas, belugas, blackfish, and of porpoises, varies from only ½ in. to 4 in. in thickness. Oil is also derived from the lips, tongue, and entrail fat of whales.

The whales or Cetacea are divisible into two main

groups: **1.** Mystacoceti, or whalebone-bearing whales. **2.** Odontoceti, or toothed whales.

The first group includes the valuable right whales (*Balæna* spp.), of which *B. mysticetus*, the Greenland or Arctic right whale, is the most valuable on account of the length of the whalebone it yields. This whale has been hunted so persistently in former times that it is now rarely found, although the western race of this species, known as the bowhead, is caught frequently in the Bering Strait.

The black right whale (*B. australis*) inhabits temperate seas of both the northern and southern hemispheres. The first group of whales also includes the genus *Balænoptera*, of which there are at least four species; these are commonly called rorqual or finback whales, and now form the chief sources of whale oil, being killed off the coasts of Finmark, the Orkney and Shetland Islands, the western coasts of the British Isles, and in the Newfoundland fisheries and elsewhere. The rorqual whales are more active and dangerous than the right whales, and on this account were not hunted generally in former times; improved methods of whaling have rendered their capture comparatively safe, and large numbers are now killed. The so-called blue or sulphur-bottom whale (*Balænoptera Sibbaldi*), the largest known living mammal, belongs to this genus, and reaches a length of 80 or even 85 ft.

The second main group of the Cetacea, the Odontoceti, includes a large number of aquatic mammals differing somewhat widely in size and outward appearance. The largest and most important member of this group is the sperm whale or cachalot (*Physeter macrocephalus*), which is widely distributed in warm seas; it is easily recognised by its enormous truncated head, of curious shape, which contains a large cavity filled with "head matter" (see p. 266). Other members of this group which are killed for the sake of their oil are the bottle-nosed whale (*Hyperoödon rostratus*); the beluga or white whale (*Delphinapterus leucas*), which is found in shoals in Arctic seas and even ascends large rivers such as the Amur and Yukon (this species gives only a small yield of oil, but is valuable as the source of the so-called "porpoise-hide" leather); and the

grindwal, black fish, or pilot whale (*Globicephalus melas*), a small whale known also as the ca'ing (driving) whale on account of the ease with which it can be frightened and driven ashore. The orca, grampus, or killer (*Orca gladiator*) also belongs to this group.

The porpoises (*Phocæna* spp.) and dolphins (*Delphinus* spp.) are also used as sources of oil.

Whaling

The introduction about 1865 of gun harpoons by Svend Foyn rendered it possible to kill whales from the vessel instead of having to approach them in small rowing boats, a method which was too hazardous to be employed with rorqual whales. Formerly the carcase of the whale was slung alongside the ship, the blubber was stripped and boiled on board, the whalebone was removed, and finally the carcase was discarded. Such methods as these are still employed in certain whale fisheries remote from land, but the method generally practised at the present time is to use the whaling vessel merely for the capture of the whales, which are then brought to land and worked up for oil, the flesh and bones being converted into manure.

The whales are sighted from the whaler by the lookout near the masthead, and are then approached until they are well within range, when the harpoon is fired. The latter is a missile about 5 ft. long, weighing over a hundred pounds; the point is composed of a bomb containing an explosive charge, and the shaft to which the bomb is screwed bears barbs which expand and so prevent the harpoon from pulling out. The gun used for firing the harpoon is mounted on the bow of the steamer, a strong hemp rope several hundred fathoms long being attached to the harpoon. When struck by the harpoon the whale "sounds" or blows and dives, and if not seriously injured, may live for a considerable time. Finally, when the whale on coming to the surface blows blood, it is approached and lanced to death. Although this method of capturing whales by explosive harpoons from the whaling vessel is much less dangerous than the older method with rowing boats, disasters sometimes occur, a motor schooner of about

fifty tons being sunk by a harpooned whale off Alaska in 1910.

Preparation of Whale Oil

On reaching the shore station the whale is hauled on to a "slip" and the blubber removed by making longitudinal cuts from head to tail, the strips of blubber being pulled off by a hook and wire rope attached to a steam winch. The strips are then put through a blubber-cutting machine which cuts them into thin slices which are carried by bucket conveyors to steam-heated vats, where the oil is boiled out. The oil is separated and the residue of blubber, after being drained free from water, is taken to hot-air driers, mixed with the flesh residue and converted into manure.

After removing the blubber, the flesh is taken from the skeleton, and is generally boiled for oil, the residue being dried for use as manure. The bones are also dried, ground, and sold for use as bone manure. In some countries, for example Japan, large quantities of whale flesh are used for human consumption. The meat is stated to be quite palatable and to resemble beef, and an Alaska whaling company is reported to be experimenting with its use for the preparation of meat extract (*The Fisheries of Alaska in* 1908 *: U.S. Bureau of Fisheries, Document* 645, p. 71), but no information as to the results of these experiments is available.

In the following table are given figures showing the approximate yields of oil obtained from the different kinds of whales (*Report of Commissioner for* 1902, *U.S. Commission of Fish and Fisheries*, p. 192):

Species of whale.	Oil barrels (31½ gallons). Minimum.	Maximum.	Average.
Right whale, Pacific	25	250	90
Right whale, Atlantic	25	150	75
Bowhead whale	30	250	100
Sperm whale	5	145	45
Humpback whale, Pacific	10	110	42
Humpback whale, Atlantic	10	100	40
Finback whale, Pacific	10	70	35
Finback whale, Atlantic	20	60	38
Californian grey whale	15	60	30
Bottlenose whale	4	25	12
Orca or killer whale	1	6	2½
Beluga or white whale	⅔	3	1⅓
Blackfish or grindwal	⅙	4	1⅛

Properties and Uses of Whale Oil

With the exception of the "head matter" of the sperm whale (see below), the oil obtained from the various species of whale is mixed and sold under the name of "whale oil," though "humpback oil" appears to be kept separate sometimes. "Train oil," formerly the name of northern whale oil, is now applied to all kinds of whale oil and even fish oils.

A number of grades of whale oil appear on the market, differing in character according to the methods of preparation and also from the fact that oil is obtained from the flesh as well as from the blubber. The oils vary in colour from water white to dark brown, the darker oils having a pronounced fishy smell. The following figures were obtained by Bull (see Lewkowitsch, *Chemical Technology and Analysis of Oils, Fats, and Waxes*, 1909, ii., 379) from the examination of a number of different grades of whale oil.

Specific gravity at $\frac{15° C.}{15° C.}$ . . .		0·916–0·927
Acid value		0·56–98·5
Saponification value		178·3–188·6
Iodine value . . .	*per cent.*	89–136
Unsaponifiable matter .	*per cent.*	1·37–3·3

The lighter coloured grades of whale oil are used as illuminating oil and in soap making. The lower grades are employed in leather dressing, jute batching, for tempering steel, and also for lubricating. The use of whale oil for edible purposes may in the near future be rendered possible by the "hydrogenation process."

Sperm Oil and Spermaceti

The sperm whale differs from most other species of whale in containing a large quantity of oily matter called "head matter" in the head cavity. This is liquid at the temperature of the live animal and is baled out, and kept apart from the blubber oil. On cooling it solidifies, and is separated by freezing and pressing into solid spermaceti and liquid sperm oil. The bottlenose whale also yields a similar head oil.

Sperm oil and spermaceti differ from other whale oils, and are classed by Lewkowitsch as waxes. Spermaceti consists almost entirely of cetyl palmitate, and is a lustrous, white, crystalline solid, which is brittle, and with care can be rubbed to powder; it melts at from 41° to 46° C., and has the following constants (Lewkowitsch, *loc. cit.* p. 780):

Specific gravity at $\frac{15° C.}{15° C.}$	0·960
Saponification value	120·6–134·6
Iodine value . . . . *per cent.*	3·8
Unsaponifiable matter, consisting principally of alcohol . . . . *per cent.*	51·5–54·2

Spermaceti is used in the manufacture of sperm candles and certain pharmaceutical and toilet preparations.

Sperm oil is a pale yellow, thin, almost odourless oil of unknown chemical composition, differing from whale oil in having lower specific gravity, saponification value, and iodine value as is shown by the following figures (Lewkowitsch, *loc. cit.* p. 730):

Specific gravity at $\frac{15° C.}{15° C.}$	0·844–0·883
Saponification value	120–147
Iodine value . . . . . . *per cent.*	81·3–90·1
Unsaponifiable matter (wax alcohols) . *per cent.*	39·0–44·3

Sperm oil is a particularly valuable lubricant, as it does not readily thicken or become sticky, and can be used, therefore, for delicate machinery; a further advantage is the fact that the viscosity does not decrease with increased temperature so rapidly as does that of other lubricating oils.

Statistics of Whaling

Reliable data as to the extent of the modern whaling industry are difficult to obtain. In the following paragraphs a few details as to the most productive whaling areas at the present time are given. The whaling industry appears to be largely carried on by Norwegians, and whaling expeditions are sent by Norwegian companies to whaling areas all over the world. Whaling has been carried on during recent years around the coasts of Newfoundland, the greater number of the whales killed being

finbacks. Thus in 1912 289 whales were killed, of which 202 were finbacks, 60 sulphur-bottom whales, 22 humpbacks, and only 5 sperm whales. The following numbers of whales and amounts of whale oil were obtained in recent years (*Ann. Rept.* 1912, *Dept. Marine and Fisheries, Newfoundland*, p. 32):

	1910.	1911.	1912.
Number of whales . .	384	335	289
Oil, gallons . . .	416,831	405,644	400,552

There are four stations on the coast of British Columbia, where whaling has been carried on very successfully during recent years, 1,107 whales being landed during 1912-13. Several species of whale are found, the commonest being the sulphur-bottom whales; humpback and finback whales are also obtained, while in 1912-13 19 sperm whales were captured; occasionally right whales are obtained. The amount of whale oil marketed in British Columbia in 1912–13 was 1,369,096 gallons, valued at £95,498.

A whaling station is in operation at Seven Islands, in the Gulf of St. Lawrence, Quebec, 90 whales being taken during the year 1912–13, including one right whale. In that year 149,310 gallons of whale oil, valued at £9,207, were marketed, as well as 11 tons of whalebone, valued at £1,018.

The total exports of whale oil from Canada in 1912 amounted to 2,422,845 gallons, valued at £203,128, and in 1913 1,618,327 gallons, valued at £109,437.

The only shore whaling station in the United States where all the parts of the whale are utilised is at Tyee, South-east Alaska, although a number of stations exist along the Arctic shores of Alaska for the purpose of trading in the whalebone obtained from whales hunted by Eskimos. The amount of whale oil produced in Alaska was 369,930 gallons, valued at £24,431 in 1910, and 250,200 gallons, valued at £18,244 in 1911. In the former year 512 cwts. of whalebone, valued at £2,055, were produced, and in 1911 516 cwts., valued at £2,607.

In the South Atlantic whaling is carried on round the Falkland Islands, and eight companies were established during 1911 in the island of South Georgia, a dependency

of the Falkland Islands, while ten companies held licences for the South Shetlands and Graham's Land. The total value of products of the industry in the South Atlantic (Falkland Islands, South Georgia, South Orkneys, South Shetlands, and Graham's Land) amounted in 1911 to £1,026,415.

A whaling station has also been established at Durban, Natal; in 1912 984 whales were landed, 6,666 tons of oil, 2,900 tons of manure, and 50 tons of "finner" whalebone were produced, valued at £110,000. A whaling station is also situated at Saldanha Bay, Cape Province.

According to the *Board of Trade Journal* (1914, **84**, 264) there were 13 whaling companies working on the West Coast of Africa in 1913, as compared with 8 in the previous year; their output of oil was approximately 149,500 barrels. There were 41 small steam whalers employed between Cape Lopez and Great Fish Bay, and it is estimated that 6,350 whales were killed in 1913, as compared with 4,250 in the previous year.

In the North Atlantic and Arctic seas the principal whaling grounds are around the Faroë Islands, Iceland, and the coast of Norway, off the coasts of the Shetlands and Hebrides, and the west coast of Ireland.

Whaling is also carried on in the seas near Japan, Argentina, the Azores, and Chile.

It is difficult to estimate the amount of whale oil imported into the United Kingdom, as the returns include under one head—"Fish oils"—train, blubber, sperm, etc., oils, the following being the quantities and values imported recently:

Fish Oil, viz. Train, Blubber, Sperm, or Head Matter

	1910.	1911.	1912.
Quantity, tons .	46,101	58,962	68,030
Value, £ . .	927,231	1,252,663	1,296,477

Of the above quantity in 1912, 33,718 tons were derived from British possessions, as follows:

	Tons.	£.
Falkland Islands . . .	10,064	167,435
Newfoundland . . .	4,406	92,285
Natal	8,829	167,919
Canada	6,900	153,108
Other British Possessions .	3,519	80,013

Other Whale Products

Apart from the whale oils already referred to, two other important and interesting products are obtained from whales, viz. whalebone and ambergris, to which reference may be made, although they do not fall strictly within the scope of this article.

Whalebone

This is the name commonly given to the baleen or plates of hornlike, lamellated material attached to the upper jaw of whales belonging to the genera *Balæna* and *Balænoptera*. The baleen plates fit into deep grooves when the mouth of the whale is closed, but they spring forward when the mouth is opened and entirely fill the space between the jaws, serving as a sieve to collect the minute organisms on which these whales feed. The number of plates amounts to as many as 360 on each side of the jaw. The baleen differs in length, formation, and quality according to the species of whale. The best is now obtained from the arctic bowhead whale and measures up to 10 ft. or more in length and 10 in. to 12 in. wide at the butt where it is fixed in the jaw. The plates taper gradually from the butt and bear a coarse, short, hairlike fringe. The bowhead whale yields more baleen than other species, one which yields 100 barrels of oil (see p. 265) yielding from 1,500–2,000 lb. of baleen; the right whales come next in yield; while the finback whales only yield a small amount (about 250 lb.) of coarse baleen, about 4 ft. in length, of inferior quality, and only worth a fraction of the value of that derived from bowhead or right whales. The relative values of the commercial grades of whalebone per ton in the London market are as follows:

"Davis Straits" and "Arctic," £650–750.
"Southern," £400–600.
"Finners," £15–30.

Owing to the irregularity of supply and to other causes, whalebone has been and is now subject to extreme fluctuations in value; for example, the value of "Arctic" whalebone was £1,100–1,400 per ton as recently as 1912.

The baleen is taken from the whale by cutting out 3 or 6 plates with the gum adhering, and is carefully stored until opportunity occurs on the homeward voyage for it to be cut out from the gum and washed. The plates are then put up in bundles of about 22, weighing about 80 lb.; this is sometimes done on board ship, but generally on shore. The tools and appliances for working the whalebone are simple, and consist of tanks and steam boxes for soaking and steaming the bone to soften it, together with special draw-knives, cutting and scraping knives and splitting machines; but considerable skill and knowledge on the part of the workmen are necessary. Details of the methods of working and of the different grades and classes of bone into which the raw whalebone is separated are given in *Document* No. 626, *U.S. Bureau of Fisheries.*

The imports of whalebone to the United Kingdom in 1911 amounted to 11,210 cwts., valued at £76,207. Of this quantity 3,132 cwts. came from Canada, 297 cwts. from Newfoundland and the Labrador coast, and 3,408 cwts. from other British possessions; the remainder from foreign countries.

Although numerous substitutes for whalebone, such as steel, rattan cane, horn, quills, celluloid, etc., have been tried and have replaced it for some uses to a large extent, the unique properties of whalebone, such as its lightness combined with great elasticity, render it almost indispensable for certain purposes. At the present time it is chiefly used in the dress, corset, and brush making trades.

Ambergris

This material is a greyish wax-like substance, hence its name *ambergris*, known from early times and once reputed to possess remarkable medicinal and other properties. The product was found sometimes in large quantities on the shores of the Indian and Pacific Oceans, and its origin was at one time the subject of much speculation. It is known now to be a product of the sperm whale of either sex. Its formation appears to be due to a diseased state of the whale (possibly of a biliary nature), as the whales in which it is found are always in poor condition

and sometimes emaciated. The ambergris may be ejected by the whale, or may be found in the intestinal canal, generally near the ventral aperture. The whalers always seek for it by probing with a cutting spade, its presence being detected by the peculiar feeling produced when it is cut by the spade. It occurs in lumps varying in weight from under 1 lb. to 150 lb. or more; it generally contains pieces of the beaks of the cuttlefish on which the sperm whales feed. On removal from the whale it is soft and possesses an offensive smell, but on exposure to air it hardens, loses its unpleasant odour, and develops its characteristic heavy aroma. Enormous quantities have occasionally been found: a mass said to weigh 600 lb. was brought home by an American whaling boat from the Bahamas in 1858, but perhaps the largest find recently disposed of was obtained in the Azores, in 1898, which weighed 274 lb. and was sold in small lots in London (*Perf. and Essential Oil Record*, 1911, **2**, 253). Ambergris has been used for centuries in ecclesiastical rites, and as a medicine and perfume especially in Asia and Africa. Its only use at the present time is in the manufacture of perfumes. Although it is not itself possessed of a strong or very pleasing odour, it has the power of "fixing" other scents. Nothing appears to be known about the chemical composition of this interesting product. As one would expect from its source, the supplies of ambergris are very irregular, and the price varies widely.

Seal Oils

The different kinds of seals (*Phocidæ*) and sea-lions (*Otaridæ*) which are killed for the sake of the hides or fur skins which they bear (see this BULLETIN, 1908, **6**, 300), also yield considerable quantities of oil from the layer of blubber under the hide. In the seals this blubber is from 1 to 3 in. in thickness, and the oil is prepared by methods similar to those employed for the manufacture of whale and fish oils. The older process of allowing the oil to exude spontaneously from the blubber as it gradually decomposes is now replaced largely by steam-boiling as in the case of whale and fish oil manufacture. Seal oil

varies somewhat in character according to the species of seal from which it is derived, but in the main resembles whale oil, although the iodine value appears to be generally higher.

The following figures are quoted (Lewkowitsch, *loc. cit.* p. 372) for oils derived from *Phoca grœnlandica*:

Specific gravity at $\frac{15° C.}{15° C.}$		0·924–0·929
Saponification value		178–196
Iodine value	*per cent.*	127–162

The oil is often mixed with whale oil and is used for similar purposes; 2,778 tons of seal oil, valued at £60,951, were exported from Newfoundland in 1911–12.

FUR-FARMING IN CANADA

Owing to the increasing scarcity and high prices of furs during recent years, attempts have been made in Canada to breed some of the more valuable fur-bearing animals in captivity, and the progress and possibilities in this direction are discussed in a report by J. W. Jones, B.S.A., recently published under the above title by the Committee on Fisheries, Game, and Fur-bearing Animals, of the Canadian Commission of Conservation.

Enquiries made in the latter part of 1912 showed that foxes of two species and various colour varieties, skunk, mink, raccoon, fisher, beaver, and muskrat, were all being experimented with on fur-farms, while attempts were also being made to domesticate the marten and otter. Up to the present most of the work on fur-farming has been done in the Maritime Provinces, but it is developing rapidly in Ontario and Quebec, and isolated fur-farms exist throughout the Western Provinces.

The most important work accomplished so far is that of rearing foxes in captivity, attention being paid chiefly to the dark or so-called silver foxes on account of the great value of the skins.

Silver-Fox Ranching.—Attempts have been made for a number of years past to rear valuable black or silver foxes

in captivity, but the experiments of Dalton and Oulton on Prince Edward Island are chiefly responsible for the establishment of this industry on its present successful commercial basis. There were in 1912 200 fox ranches on Prince Edward Island, owning 650 silver foxes and also a number of less valuable cross-bred and red foxes. The estimated total number of foxes in Canada in 1912 was as follows: silver 800, cross 250, bastard and red, 1,450; the total number of ranches in that year was estimated at 241. The method of fox ranching may be briefly described as follows:

The foxes are kept in separate pens measuring about 25 ft. by 50 ft., constructed of strong wire netting 10 ft. to 15 ft. in height. As the foxes are powerful diggers it is necessary to place a carpet wire several feet in width inside the fence, and also to sink the wire fences about 4 ft. in the ground, or at any rate down to the level of the "hard-pan" when this exists. As the foxes are also good climbers, an overhanging strip of wire is necessary at the top, or this may be obviated by using plain sheet iron for the upper part of the fences; the latter is specially advantageous as the foxes cannot climb it and are consequently free from any chance of damage due to falls.

Several pens are placed together and surrounded at some distance by a fence, 10 ft. to 15 ft. high, the objects of which are to prevent escape of foxes which may get out of the pens, and to keep animals and strangers away from them. The outer fences are composed of wire-netting, or of boards 6 ft. to 10 ft. high, with 4 ft. of wire netting at the top. In either case a strip of overhanging netting is fixed to the top, and a carpet wire 3 ft. wide placed on the ground inside the fence.

The most suitable locality for the ranch is a well-drained, wooded site, as this keeps at an equable temperature throughout the year, and is less liable to snowdrifts, while the trees form excellent cover for the shy foxes.

The foxes are provided with wooden kennels which are carefully constructed inside so that no rough projections exist which can damage the fur; part of the kennel is constructed as a small nest carefully insulated so that the

female can keep the young warm. Mating takes place early in the year, and the young are born about fifty days later; after mating the male is generally separated. Great care is necessary during the breeding season, and after the young are born, to prevent the animals being alarmed. So great is the danger that laws have been enacted in New Brunswick and Quebec imposing heavy fines for trespass on the ranches. A litter consists of one to nine pups, which can be separated from the mother when three months old. The young foxes generally mate when ten months old and continue prolific for ten or eleven years. Food of a very varied nature is fed to the foxes; meat of all kinds, fish, milk, and corn-meal being among the principal foods used, while dog biscuits are also useful. So far no serious diseases have occurred on the ranches.

The fur becomes prime in November, but is heavier in December, and the foxes are killed at the end of the latter month. Some owners kill the foxes at eight months of age, when they are said to yield fur as good as that of older foxes; other owners prefer to kill when twenty months old. Killing is effected by breaking the neck or by crushing the chest; but the use of chloroform or other poison is more humane and cannot damage the fur, and is to be recommended. The skinning of the fox must be carried out with extreme care. Incisions are made on the inside of the hind legs, and the whole of the skin of the body is stripped off without cutting. The skins are then stretched on a board, flesh side out, and all fat, etc., removed. The skin is allowed to dry for one day and is then turned fur side outwards. Finally it is stretched over a board and allowed to dry thoroughly. When dry the pelts are sewn in muslin and carefully packed.

A point of great importance which has been discovered in silver fox breeding is that by mating a pure black (or silver) fox with a pure red fox, litters of cubs can be obtained in two generations, half the number of which are pure silver and the other half red.

Up to the present time the majority of the silver foxes bred have been sold for breeding purposes and have fetched very high prices, $20,000 (about £4,000) being recorded for

one pair in 1912. A fair number of skins of ranch-bred foxes have been sold and have fetched high prices; at present the record price is £580 paid for a single skin on the London market, while half a dozen skins have sold at £500 or more apiece. The average price for silver fox skins sold in London in 1911 was about £60. This includes wild and ranch-bred skins. The reasons for the high prices paid for silver fox skins are the durability and beauty of the skins; fine-grade skins are composed of bluish-black heavy fur with silvery hairs evenly distributed over the pelt.

The fox-breeding industry is at present in a very speculative condition, but there seems little doubt that it should prove very remunerative if carried out on a fair scale under intelligent management. Full details as to management, food, etc., are given in the work quoted.

Polar or Arctic Fox (*Vulpes lagopus*).—These are much less valuable than the silver fox, but the blue Arctic fox skins are worth about $30, and fine skins may fetch as much as $75 or more. A considerable number of blue foxes were imported into Canada in 1912, but so far no information is available as to the results of the experiments in breeding these animals in the Dominion. Blue fox farming has, however, been carried on for some years past in several small islands off the coast of Alaska. At present most of the attempts to breed this fox appear to have taken the form not of ranching but of allowing the foxes to roam in their natural habitat, and of improving the conditions of their life by feeding during periods of scarcity. On the island of St. George (Pribiloff Islands, Alaska) systematic feeding of the foxes since 1896 has been pursued. For this purpose the carcases of seals have been salted down and fed to the foxes during the winter; other food has also been used when seal-meat is not available. The management of the fox industry in St. George is under the control of a Government Agent, who decides which animals are to be killed or released for breeding. The foxes are caught readily in pens or traps baited with food. White foxes have been exterminated on the island as far as possible, as the skins are of comparatively little value. In 1907–1908,

446 foxes were killed and about 270 pairs released for breeding, and it is stated that the numbers could be indefinitely increased. The exploitation of blue foxes on a similar plan on small islands where food is easily obtainable should prove successful.

Raccoon (*Procyon lotor*).—So far this animal does not seem to have been reared in captivity, but it is likely that this could be done successfully in the northern districts of Canada.

Mink (*Putorius vison*).—Mink farming is still in the experimental stage, but it has been shown that the animal can be reared successfully in captivity. Various systems are being tried, and a French Company on Lac Chaud, Quebec, has enclosed an area on the shore where the mink live under natural conditions; this seems likely to prove successful. They can also be kept in colonies of families, or in separate pens.

Marten or American Sable (*Mustela americana*).—Although very savage, it seems likely that these can be bred in captivity, and attempts are being made by Canadian fur farmers to obtain marten for breeding.

Fisher or Pennant Marten (*Mustela Pennanti*).—Only two ranches were found by Mr. Jones where fishers were kept. In one case the experiment seemed fairly successful, although no young had yet been produced, and it is likely that interest will be taken in the fisher, as first-class skins were worth $75 to $100 in 1912.

Canadian Otter (*Lutra canadensis*).—Canadian otter skins are said to be superior to those of otters from other localities, and were quoted at $20 to $25 each, if of dark colour, in January 1913. Otters have been kept successfully in many zoological gardens, but have not bred; if they can be bred in captivity the industry should prove profitable, as they are easy to keep.

Skunk (*Mephitis mephitica*).—In common with other skins, skunk skins have increased in value recently, No. 1 northern skunk fetching $4·25 in 1912, and if the price continues to rise skunk farming should become a profitable undertaking if carried on on a large scale. So far, however, skunks have been bred only on a small scale.

Muskrat (*Fiber zibethicus*).—The skins of this small animal are not very valuable, but the species breeds freely, and can be reared in large numbers on protected marshes; the fur, musk bags, and flesh are all readily saleable.

Beaver (*Castor canadensis*).—Owing to persistent trapping in the past the beaver is in danger of becoming extinct in Canada, as it has done in most parts of Europe. It cannot be farmed, as it requires large areas to furnish food; the only plan is to encourage the beavers to multiply by protection in large game preserves under constant patrol. In the Algonquin National Park, Ontario, beavers yield a large revenue yearly.

TIN RESOURCES OF MALAYA AND INDIA

TIN has always been to a large extent a British product. In the time of the Phœnicians, and long after, Cornwall appears to have furnished the greater part of the world's supply of the metal, and to-day more than half of the total output is produced within the British Empire. This is shown by the following table, which gives the world's output of tin for 1911, the last year for which complete figures are available.

British Empire.	*Long tons.*	Foreign Countries.	*Long tons.*
Malay States	44,136	Bolivia	21,887
Australia	6,888	Dutch East Indies	19,909
United Kingdom	4,870	China	5,958
Union of South Africa	2,308	Siam	5,928
Nigeria	2,157	Japan	144
India	138	United States	60
	60,497	Portugal	50
		Indo-China	40
		German Empire	35
		Austria-Hungary	19
Total British Empire	60,497	Spain	15
,, Foreign Countries	54,051	Italy	6
	114,548		54,051

In the present article it is proposed to describe the tin fields of the Malay Peninsula and India, while the Australian and African occurrences will be dealt with in a later number of this BULLETIN.

The Malay Peninsula

I. *General*

The sequence of rocks in the Malay Peninsula, as described by Mr. J. B. Scrivenor, the Government Geologist, is indicated in the following table:

Sedimentary	*Igneous*
Recent alluvium, lignite, torrential deposits, etc.	
Tertiary coal measures of Selangor.	Dolerite dykes cutting Mesozoic granite.
(*Unconformity*)	Mesozoic granite, stanniferous.
Gondwana Rocks — conglomerates, quartzites, shales, and slates; stanniferous boulder clay (Gopeng Beds).	Pahang Volcanic Series—quartz-porphyry, porphyry, granophyre, dacite, andesite, augite-andesite, dolerite.
(*Unconformity*)	
Raub Series — limestones and calcareous shales; radiolarian chert.	
	Palæozoic granite—stanniferous; not known *in situ*.

The Main Range, which forms the principal watershed of the Peninsula and the dividing line between Perak and Selangor on the west and Kelantan and Pahang on the east, is formed of granite, which appears to have been intruded later than the Triassic period and before the Eocene. Offshoots of this granitic axis form hills in Province Wellesley and Penang, to the east of the Larut district, in the Dindings, and in the Kledang Range, between the Perak and Kinta rivers. On the western side of the Peninsula there are also quartzite hills such as the Semanggol Range in Perak, the hills near Telok Anson, and those which occupy a large part of Selangor, as well as limestone hills with precipitous sides, which are well developed in the Kinta district of Perak.

Immediately to the east of the Main Range, in Pahang, is a chain of foothills composed of quartzite, conglomerate, and shale. Farther east lies the Benom Range, formed of granite which is for the most part hornblendic, and beyond that is a belt of hilly country where the Gondwana rocks attain their greatest development.

By far the greater part of the Malay tin comes from

what are generally classed as alluvial deposits, lode mining furnishing a comparatively small proportion. But the so-called alluvial deposits differ greatly among themselves in character, in origin, and in age. Among the granite hills, for example, many of the valleys are full of huge boulders of resistant granite from which the decomposed matrix has been washed away. These "core-boulders" act as natural riffles, and Chinese miners burrow beneath them in search of the rich pay-dirt. For this they sometimes pay with their lives, through the collapse of the unstable mass of boulders.

In the limestone hills, again, tin-bearing gravel, sand, and silt have been washed into caves and fissures, which may now be high above stream-level. Here they have become stained with iron oxide, and sometimes cemented with calcite, requiring to be crushed before the cassiterite (tinstone) can be recovered.

An important series of clays with angular tin ore, and sometimes containing boulders, is now known to be a glacial deposit of Gondwana age (Permo-Carboniferous). These are the Gopeng Beds of the western states.

The lodes that are worked for tin include veins, pockets, stockworks, and impregnations in granite, shale, sandstone, and limestone. In many cases the granite or pegmatite is so decomposed as to be readily worked by pick and shovel, or even by the jet of water from a monitor.

Various methods are employed for winning the cassiterite from the alluvial deposits and soft igneous and sedimentary rocks. On small patches of alluvium many Chinese mines consist of a simple *lampan* or ground sluice into which the pay-dirt (*karang*) is hoed from the adjacent hillside. On larger properties a *lumbong* or opencast mine is opened, from which the *karang* is carried in baskets to the sluice boxes. Mining by shafts and galleries is sometimes adopted. In some cases, after the richest ground has been extracted in this way by Chinese miners, the property may still yield good profits if worked by hydraulic monitors. Recently gravel-pump dredges of Australian design have been successfully employed on low-grade properties in the Kinta district.

Associated with detrital tin ore in the crude concentrates, there are other heavy minerals which are separated from the cassiterite by careful washing. The rejected portion, known as *amang*, may be treated by an electro-magnetic process to recover what cassiterite remains in it, as well as other minerals of value, such as wolframite and monazite. Other minerals occurring in the *amang* are ilmenite, magnetite, zircon, rutile, garnet, tourmaline, topaz, corundum, xenotime, andalusite, tremolite, hæmatite, limonite, pyrite, arsenopyrite, chalybite, anatase, brookite, scheelite, galena, native copper, columbite, and strüverite. Several samples of *amangs*, and of minerals isolated from them, have been examined at the Imperial Institute (see this BULLETIN 1906, **4**, 301; 1908, **6**, 155; 1911, **9**, 354; and 1913, **11**, 243).

The Federated Malay States, and particularly Perak and Selangor, produce all but a trifling proportion of the tin output of the Peninsula. The relative importance of the different States as tin producers is shown in the following tables:

	Tin exported in 1912.	
	Quantity.[1] *Long tons.*	Value. £.
Perak	28,407	5,757,793
Selangor	15,202	3,079,388
Negri Sembilan	1,730	349,769
Pahang	2,663	628,597
Total for Federated Malay States	48,002	9,815,547

[1] *Weight of tin exported as metal or in ore (calculated at* 70 *per cent. of the gross weight of the ore).*

	Tin ore exported in 1912.	
	Quantity.[1] *Long tons.*	Value. £.
Kedah	835	111,339
Perlis	188	(No returns)
Kelantan	19	2,710
Trengganu	403	56,607
Total for Protected Malay States	1,445	...

[1] *Gross weight of ore.*

Large quantities of metallic tin are exported from the Straits Settlements, being smelted therein from ores produced in the Federated Malay States. No tin ore is produced in Singapore or Penang, but Malacca produced

11 tons in 1912. A small amount is obtained in the State of Johore, but no statistics are available.

II. *Perak*

The geology of the Kinta district, Perak, was summarised in this BULLETIN (1913, **11**, 537). Crystalline limestone underlies the wide valley through which the Kinta river flows. It is covered in part by clays and boulder clays (Gopeng Beds) of Gondwana age. The younger Gondwana rocks are mostly shales and quartzites. Fault-blocks of the limestone form precipitous hills rising above these younger beds. The valley is flanked by the granite of the Main Range on the east, and of the Kledang Range on the west. The intrusion of this granite, which is evidently younger than the Gondwana rocks, was accompanied by pneumatolitic action and the formation of tin-bearing veins. But the boulder clays contain detrital cassiterite which cannot be derived from the Mesozoic granites of the Main and Kledang ranges, but must be attributed to some earlier stanniferous intrusion. Boulders of tourmaline-corundum rock occur in these beds. The recent deposits include sand with seams of lignite and stanniferous alluvium and cave deposits. Even the soil is stanniferous, especially where the Gopeng Beds outcrop.

The principal mining areas in the Kinta District are as follows, beginning in the south-east, proceeding northward along the east side of the valley, and returning southward along the west side:

Kampar.—In this district the old Gondwana clays overlying limestone are worked in the low-lying country, while shallow alluvial deposits on the granite slopes of Bujang Malaka have also yielded ore. In the Ulu of the Petai a pipe containing felspar, tourmaline, cassiterite, and metallic sulphides was found in a tourmaline-felspar country rock. The pipe was at first only slightly inclined to the horizontal, and measured about 8 ft. by 13 ft. The ore is said to have yielded 5 per cent. black tin, and about 1,000 pikuls were won from it (1 pikul = 133·3 lb.). The apparent absence of quartz and the freshness of the felspar are peculiar features of this occurrence.

Malim Nawar.—Here sandy soil resting on limestone is washed for cassiterite. It appears to be the coarser residue of Gondwana clays.

Sungei Siput.—This village is situated on the Depang river south of the limestone mass of Gunong Tempurong. In Jehosaphat's (Jesophat's) Valley an old fault-fissure, trending N.N.W. and S.S.E., has become filled with detrital quartz, tourmaline, iron ores, topaz and cassiterite, which were subsequently cemented with iron-stained calcite to form a rich "vein" about 4 ft. wide. A large cave in the neighbourhood is also known to contain detrital tin ore.

Gopeng.—This area includes the Gopeng, New Gopeng, Ulu Gopeng, Kinta Tin, Tekka, and Sungei Raia mines. On many of these properties hydraulic operations on a large scale are carried on, the monitors removing both clays and boulder clays and decomposed granite. Interesting sections of these rocks and the veins that traverse them are thus exposed.

Pulai.—Most of the tin ore of this field has been obtained from the glacial deposits, though it also occurs in the granite and in caves in the limestone. At the Kramat Pulai mine the junction of boulder clay and granite, with a kaolin vein in the former, was recently exposed.

Ulu Piah.—This mine is situated near Ampang on a patch of the glacial beds faulted down between the granite and the limestone.

Tambun.—In both the Tambun and New Tambun mines the glacial clays, which are practically free from boulders, are cut by hand and puddled to separate the tin ore.

Tanjong Rambutan.—Here, not far from the northern boundary of the Kinta district, there are two mines—the Rambutan and the Kinta Association. In the latter the glacial clays are remarkable for the number of large quartz boulders they contain.

Menglembu.—On the west side of the Kinta valley, near Menglembu village, a number of ore-bodies have been found in the granite of the Kledang Range. Some of these ore-bodies are ordinary veins, while others may be described as pipes. To the former class belongs

the lode on Bukit Kambing, which trends N.E. and S.W., and has a dip of 32° from the vertical. The width of the portion worked was 4 ft., and the average yield of ore 6 per cent. Work was abandoned when the yield fell to about 2 per cent. black tin. Several other lodes are known; they have a similar strike to the Bukit Kambing lode, and like it are associated with fairly fresh felspar and much tourmaline. Fluorspar is sometimes present.

The pipe-like mode of occurrence is seen in the workings of the Menglembu Lode Syndicate. Here the granite is strongly jointed and contains in places numerous minute veins of cassiterite set close together. Their direction is about 20° E. of N., cutting the joints at an angle of about 45°. The little veins form ore-bodies which, though very irregular, average about 60 ft. by 20 ft. in horizontal dimensions, while one of them has been followed down for 500 ft.

Penkalan.—Three large excavations are worked to the north of Lahat. They are all in the Gondwana clays. In No. 2 a fault with a throw of about 20 ft. has been exposed in the limestone floor, while in No. 3 small bodies of ore occur in the limestone itself, and the remains of others on its irregular surface.

Lahat.—In this great opencast mine, stiff blue clays of Gondwana age overlie stanniferous granite which rises to the west, and are themselves covered by beds of sand and clay with seams of lignite. These recent deposits are a more important source of tin ore than the Gondwana clays themselves.

Rotan Dahan.—Here angular tin ore is distributed throughout a series of clays, 140 ft. thick in places.

Redhills and Pusing Lama.—Both these mines are in red clays and boulder clays with abundant boulders of tourmaline-corundum rock, and in both tin-bearing veins have been found in addition to the detrital tin ore.

Pusing Bharu.—Here also the tourmaline-corundum rock is abundant in the boulder clays. These are covered by stanniferous sandy beds and lignite. The

limestone floor, by solution, gives rise to well-marked "cups," which are lined with Gondwana boulder clays and filled with sand and lignite.

Siputeh.—Here the cups are even better developed, and caused great trouble when the mine was first opened. The rare occurrence of a tourmaline vein in the limestone has been noticed here.

Tronoh. — A large opencast mine was formerly worked by a system of shafts and galleries in the so-called "Tronoh deep-lead." This is really a huge trough or elongated cup in the limestone, filled with Gondwana clays below and sands and lignite above. The western boundary is a reversed fault which brings down the younger Gondwana rocks, quartzites and shales with granite intrusions.

Tanjong Toh Allang.—The country here consists of quartzites, shales, and tourmaline schists, but there is some evidence that the older Gondwana glacial beds occur below. The most prosperous mines are in the vicinity of kaolinised granite intrusions.

Tin Ore in Limestone.—The deposits of non-detrital cassiterite in limestone may conveniently be described together. They occur in the form of veins and pipes, the latter being as a rule the more valuable. Veins have been found at Siak, near Siputeh, at Ayer Dangsang, near Lahat, where a pipe opened out into a vein in depth; and at Penkalan No. 3 mine, where several small stringers have been noted. None of these veins have proved worth following up, but in two cases they gave rise to very rich patches of ore owing to the solution of the limestone.

Pipes have been found at Lahat, Ayer Dangsang, Menglembu, and Changkat Pari. In the case of the last three the gangue is mainly calcite, though quartz occurs also, and the cassiterite is associated with pyrite, chalcopyrite, bornite, arsenopyrite, and antimonite. Fluorite and tremolite are common, but tourmaline is very rare. The Lahat pipe had a similar origin, but the calcite had been dissolved and the sulphides oxidised by descending water.

The Larut district, to the north-west of the Kinta district, is another important tin area. The country round Taiping is an alluvial flat, rich in cassiterite, which is bounded on the east by the granite hills of the Taiping Range, and on the west by the quartzite Semanggol Range. Lode mining has been carried on at Selama and Blanda Mabok, the lode at the latter place yielding also argentiferous galena and gold.

To the south of the Kinta district, at Bruseh, a stock-work of tin-bearing veins in schist is being worked between the Pinang and Durian rivers. The veins are numerous, and generally rich in tourmaline, and the average thickness is about an inch. A little wolframite is found. The decomposed schist is worked by monitors, the average yield being about ½ kati per cubic yard (1 kati = 1·3 lb.).

III. *Selangor*

Near Tanjong Malim, in the north of Selangor, the operations are somewhat similar to those at Bruseh. Here there are numerous veins of quartz with coarse cassiterite traversing soft sandstone and shale.

Farther south, at Serendah, decomposed granite is worked by monitors on the site of old lampans. The granite is traversed by a few veins of quartz and of a granite modification resembling greisen; these veins carry cassiterite.

Kuala Lumpur is the centre of the most important mining district in Selangor, the output of which is second only to that of the Kinta district. At Salak South a pegmatite rich in tin is worked. The Sungei Besi occurrence, like that at Tronoh, consists of unusually rich deposits occupying a great cavity at the junction of limestone and granitic rocks.

IV. *Negri Sembilan*

In the neighbourhood of Seremban decomposed pegmatite with stanniferous quartz veinlets is worked by means of monitors. In Jelebu the Triang and its tributaries yield cassiterite, and the Kuala Pilah district also contains workable deposits.

V. *Pahang*

The country to the east of the Main Range is not so rich in tin ore as that to the west. There are, however, alluvial workings near the western boundary of Pahang (Bentong, Tras, Machi), and in the Blat (Belat) valley in the Kuantan district. Lode mining is carried on near the headwaters of the Kuantan river in the north-east of the State.

The Machi tin field lies to the south of Bentong. The deposit is alluvial, and generally not more than 12 ft. in depth. The cassiterite is angular and varies so much in grain that a large proportion is lost by the crude Chinese method of dressing it. Small lodes exist in the locality. One of these was found to contain quartz, yellow garnet, cassiterite, zinc-blende, arsenopyrite, and pyroxene.

The alluvial flats at Bentong have been worked for tin, but at present the work is confined to the higher valleys of the Main Range, on the boundary of Pahang and Selangor. In these localities cost of transport is a very serious matter, all supplies and ore having to be carried by coolies for long distances over rough jungle paths. The workings are in shallow alluvium and decomposed granite. In the Chinchong valley boulders of a rock composed of quartz, topaz, and cassiterite have been found and traced to the parent rock. In the Ulu of the Kenong angular cassiterite of varying grain is won, and near Bukit Fraser stanniferous granite and pegmatite occur. On Gunong Gapis, above Tras, a soft granitic rock is sluiced for cassiterite. A small lode on the Gau stream, traversing Gondwana rocks, contains cassiterite associated with pyrite, chalcopyrite, bornite, arsenopyrite, blende, chalybite, calcite, quartz, and garnet. The Liang and Triang valleys also contain stanniferous alluvium.

There are also alluvial workings on the Blat river, a tributary of the Kuantan near its mouth.

The lodes on the Sungei Lembing, a tributary of the Kuantan, run east and west, and are from 2 to 10 ft. wide. The country rock is an altered sediment overlying granite, and the geological conditions generally resemble those of

Cornwall. The lodes carry workable amounts of copper as well as tin, especially in the upper part.

VI. *Malacca*

On the north-west coast of Malacca, for some distance south of Kuala Linggi, the sand and mud below high-tide mark have been washed for tin. The source of the mineral is a schist with numerous quartz veinlets carrying cassiterite. The schist overlies granite, and forms the shore for some distance. This schist has been mined, but most of the tin produced in Malacca has come from the beach deposits, where the material has been disintegrated and concentrated by the waves.

At Chin-Chin some tinstone has been obtained from the soil, but ferruginous cement ("laterite") interferes with hydraulic operations.

VII. *Trengganu*

In Kemaman, in the south of Trengganu, lode mining is carried on at Bundi and Sungei Ayam.

The Bundi deposit consists of soft clayey and sandy material, with masses of quartz, sulphides and iron oxides, between walls of hard granite. The length is 1,575 ft., and the greatest breadth 120 ft., and the bottom has been reached only at Glen Reef, the most northerly working. The cassiterite occurs in the soft clay and in the ironstone, in the form of slender, pale yellow needles, sometimes forming spongy masses.

The Sungei Ayam lode is from 2 to 3 ft. wide. It is very flat, and is mined by a succession of shallow stope-drives.

Sungei Sendok, Sungei Paka, and Dungun also produce some tin, and at Dungun wolframite also occurs.

VIII. *Kelantan*

Most of the tin produced in this State is obtained from a mine on a tributary of the Nenggiri, and from the Bukit Yong concession. Tin ore is known to occur in other localities, and further prospecting is likely to lead to the discovery of deposits of value.

IX. *Kedah*

There are four mining districts in Kedah, viz. Kuala Muda, Kulim, Krian, and Kubang Pasu. The greater part of the tin exported from Kuala Muda district is won in the alluvial workings near the town of Semiling, on the Merbok river, at the foot of the southern slope of Kedah Peak.

X. *Perlis*

In the State of Perlis, which lies to the north of Kedah, cassiterite is won from caves and underground streams in the limestone hills on the Setul border. The caves hitherto worked have been below water-level, and have to be pumped dry before their tin contents can be estimated. It is probable that prospecting may reveal other tin-bearing caves at a higher level, but the difficulties of transport are very great, and the conditions are not such as to attract Chinese prospectors in any number. Moreover, the cassiterite in the caves is very fine, and the detrital material in many cases is cemented by iron oxide; this necessitates crushing and the production of a large amount of slimes, with serious danger to the paddy fields in time of flood.

Glossary of the more important words connected with Malay mining and place-names

Amang, the heavy minerals associated with cassiterite or gold.
Batu, rock.
Besar, big.
Besi, iron.
Bukit, a hill.
Changkat, a hillock.
Dollar, the Malay dollar, value 2*s.* 4*d.*
Ginting, a mountain pass.
Goa, a cave.
Gunong, a mountain.
Jeram, a rapid.
Karang, pay-dirt.
Kati, 1·3 lb.
Klian, a mine.
Kuala, a river mouth.
Lampan, a sluicing mine.
Landak, a porcupine.
Lembing, a light spear.
Lubok, a pool.
Lumbong, a hole, a mine.
Mas, gold.
Pikul, 133·3 lb. (100 katis).
Puloh, an island.
Siput, a snail.
Sungei, a river.
Tanjong, a cape.
Tujoh, seven.
Ulu, the part of a river-basin near the source.

India

The tin-producing districts of India are those of Mergui and Tavoy in South Burma. These form part of the great

tin-bearing belt which stretches from Siam through the Malay States to Banka and Billiton.

In Mergui the principal hills, which have a north and south trend, are of granite, with flanking hills of unfossiliferous schists, slates, sandstones, and quartzites. These sediments are referred to as the Mergui series; their age is unknown. Cassiterite is found under the following conditions:

1. As a constituent of decomposed pegmatite rich in tourmaline and muscovite, locally known as "Kra."

2. In massive quartz-segregations in and on the outskirts of granitic hills. Some of these segregations also carry wolframite, pyrite, and chalcopyrite.

3. In quartz veins and stringers in ground adjacent to decomposing pegmatite.

4. Hillside talus accumulations, gravel deposits, and alluvial flats. These form the deposits most usually worked.

Most of the workings are on the mainland, the chief centres being Maliwun, Karathuri, and Bokypin, but cassiterite is also known to occur in the gravels of King's, Kissering, and Davies Islands in the Mergui Archipelago.

In the Tavoy district also the alluvial deposits are washed for cassiterite, which is often associated with wolframite and sometimes with gold. The cassiterite is derived from the granite and also from quartz veins in the Mergui series.

Tin has also been produced in small amounts at Bawdwin in the Northern Shan States.

GENERAL NOTES

Mineral Survey of Ceylon.—A Mineral Survey has been conducted in Ceylon under the general supervision of the Director of the Imperial Institute since 1903. Reports on the work of the Survey are published periodically in the Miscellaneous Series of Colonial Reports, and a new number, containing reports Nos. XXVI. and XXVII., has been published in this series recently (No. 87 [Cd. 7175]). The following subjects are dealt with in these two Reports:

(1) The composition of a number of rare earth and

other minerals collected by the Survey during 1908–9, which had been the subject of special investigations at the Imperial Institute; (2) the field-work accomplished by the Survey during 1909–10, and the results of examination at the Imperial Institute of the minerals collected during that year; and (3) minerals collected during a visit of inspection paid by the Director of the Imperial Institute in 1910 to Ceylon in connection with the work of the Mineral Survey.

The results recorded illustrate again the comparatively wide distribution of thorium-bearing minerals in Ceylon and the great diversity of minerals of this type found there. Two of the concentrates examined contained 3·5 and 3·08 per cent. of thoria respectively, the thorium-bearing mineral in each case being monazite. In another concentrate both monazite and thorianite were present, the percentage of thoria being 4·82. A mineral from Kondurugala was found to contain over 36 per cent. of thoria. Other minerals of economic interest dealt with in the Reports include aluminium phosphate, chromite, molybdenite, apatite, kaolin, marcasite, and stibnite (antimony sulphide).

Mineral Production of Victoria.—According to the *Annual Report* of the Secretary for Mines in the State of Victoria, Australia, for the year 1912, the total value of the mineral output for that year was £2,331,294. This is a decrease of £132,571 on the value of the output for the preceding year. As usual, gold and coal were responsible for almost the whole of the output, these two items together contributing not less than 98·6 per cent. of the total.

The total gold output was 480,131 oz. (fine), valued at £2,039,464, a decrease of £101,391 on that for 1911. The gold treated at the Mint yielded 17,424 oz. (fine) of silver, valued at £2,200.

The total coal output was 589,143 tons, valued at the pit's mouth at £258,455 (8*s.* 9*d.* per ton), a decrease of £40,374 on the preceding year's output. Of this the State coal mine at Wonthaggi contributed 455,659 tons, valued at £184,056, the profit at this mine for the year ending June 30, 1912, being £9,833. It is estimated that there is 26½ million tons of coal available at the State mine, in seams not less than 2½ ft. thick. The introduction of coal cutters, however, has made possible the working of thinner seams, and in one place a seam 18 in. thick is being worked. The working of these thinner seams will increase substantially the total amount of coal available.

In addition to the above output of black coal, 4,012 tons of brown coal was raised, valued at £866.

Among the less important items in the output are antimony ore (£16,162), tin ore (£5,733), diatomaceous earth (£3,400), gypsum (£3,359), magnesite (£633), tungsten ore (£574), and kaolin (£342).

Mineral Production of Queensland.—In his *Annual Report* for the year 1912, the Under Secretary for Mines in Queensland gives the value of the total mineral output for that year as £4,175,355, an increase of £514,292 on that for 1911.

The output of gold was 347,946 oz. (fine), valued at £1,477,979, a decrease of £162,340 on that of the preceding year. A notable feature concerning the gold output is the fact that whereas in 1900—the year in which the gold output reached its zenith—the value of gold won from ores of the baser metals was only £5,200, the value from the same source during 1912 was £556,159.

Copper shows a large increase, the output being valued at £1,698,280 compared with £1,151,351 in 1911. Of this amount Cloncurry contributed £761,755. It is claimed for Cloncurry that this is the richest and most extensive copper field in Australia.

The tin output was valued at £364,503, an increase of £56,656 on that for 1911, due to increased activity in existing fields rather than to any fresh discoveries, though the high price of tin stimulated prospecting.

The combined output of the various coalfields again shows an increase, the total quantity of coal raised in the State being 902,166 tons, valued at £338,264. This is an increase in amount of 10,598 tons and in value of £14,266 on the 1911 output, whilst the average value of 7*s.* 6*d.* per ton was higher by 3*d.* than that for 1911.

Other notable features in the output are silver (£66,188), lead (£55,667), bismuth and wolfram (£77,082), gems (£40,016), limestone (£24,176), molybdenite (£17,349), ironstone (£9,035), opal (£3,000), and fireclay (£2,535).

The item "gems" refers to the sapphire-mining industry at Anakie, where there is a ready sale for all classes of stone, and where the advance in the prices offered for sapphires, and the advent of several new buyers, gave considerable stimulus to the industry, the output increasing in value from £24,393 in 1911 to £40,016 in 1912. This included £32,372 for gemstones and £7,644 for corundum used in other ways.

Mineral Production of Western Australia.—According to the *Report of the Department of Mines, Western Australia*, for the year 1912, the value of the total mineral output of the State for that year was £5,760,207, being £345,646 less than that for the previous year. The chief items are as follows:

	Value.	Variation as compared with 1911.
Gold	£5,448,385	− £374,690
Coal	135,857	+ 24,703
Tin	70,578	+ 15,358
Copper	60,537	− 17,581
Lead ore	22,565	+ 7,563
Silver	16,353	− 1,980

As regards gold there has been a fairly steady yearly decrease since 1903, in which year the output reached its maximum. The average value per ton of gold ore treated in the State as a whole fell from 41·19 shillings in 1911 to 39·64 shillings in 1912, and in the East Coolgardie goldfield, from which over 50 per cent. of the State's yield is obtained, the average value fell from 38·14 to 36·37 shillings per ton.

The improvement in the tin output was due to increased activity in the Greenbushes tinfield, the output in the Pilbara field being rather less than in the preceding year.

The increased output of coal is attributed to the more general use of improved machinery on the Collie coalfield, where six mines are working.

No tantalite, wolfram, asbestos, or mica was raised during the year.

The Government continues to render assistance to *bona fide* prospectors by the loan of equipment and means of transport, and the whole of the outfit is in constant use. The area held for prospecting was 9,644 acres, and though this is rather less than the area held in the preceding year, it is an indication that active prospecting is going on.

Petroleum Prospects in the Union of South Africa.—The Union Government of South Africa has issued a *Report on the Petroleum Prospects in the Union of South Africa*, by E. H. C. Craig (Pretoria: Government Printing and Stationery Office, 1914). In his introduction Mr. Craig deals with various fallacies concerning the indications of petroleum occurrence. Of these perhaps the most familiar is the confusion by some people of films of iron oxide on water with oil films, an error made very frequently by inexperienced or badly-trained prospectors. More excusable, perhaps, is the tendency of some to regard occurrences of oil shale and natural gas as indications of the occurrence of petroleum. However, as pointed out in this report, oil shale does not contain petroleum as such, but yields it only as a disintegration product when distilled under suitable conditions. "Thus the occurrence of oil shale is no 'indication of petroleum,' and may have little or no bearing upon the question of the possibility of discovering oil. The occurrence of coal is a similar piece of evidence. . . . The occurrence of natural gas also is not necessarily any indication of petroleum."

It is further remarked that many people erroneously regard saltpans as indicators of petroleum, owing to the frequent association of brine and brine springs with petroliferous strata. Still others have argued that as South Africa provides a unique instance of diamond occurrence, there is no reason why it should not also provide a unique example in the mode of occurrence of

petroleum—an attitude of mind which is indeed absurdly optimistic.

The conditions that require to be considered in connection with the occurrence of oil are (1) the presence of an ample supply of oil-forming carbonaceous material in the sediments, (2) the conditions under which the sediments have been deposited, and (3) the geological structure. According to Mr. Craig, an oil-field can be predicted with certainty where these three conditions are favourable.

After an analysis of the geological conditions prevailing in South Africa, he concludes that the only system of sedimentary rocks in which oil-fields can be hopefully looked for is the Karroo system. Even in this system, however, except along a narrow strip at the southern edge of the Karroo in Cape Province, and possibly also in north-eastern Natal, the tectonic conditions are not favourable; and as regards the occurrence of oil-fields he concludes that the prospects for South Africa are not hopeful.

As regards natural gas there appear to be coal-measure areas in the Transvaal and Natal where it can be obtained in fair quantity, but Mr. Craig is of opinion that supplies of gas under sufficient pressure to supply towns at a distance from the gas-fields are not likely to be found.

As regards oil-shales the tone of the report is rather more hopeful. Numerous oil-shales occur in the Transvaal and Natal coal-measures, and though none of these yields as much oil as the best Scottish oil-shales, some of them yield a fair amount. One shale yielded in a laboratory test 30 gallons of oil and 64 lb. 13 oz. of ammonium sulphate per ton. Another yielded 27·1 gallons of oil per ton, comprising 10·9 gallons of petrol, 12·4 of kerosene, and 3·8 of lubricating oils. Mr. Craig concludes that the prospecting of the folded belt of the Karroo system for crude petroleum and natural gas is of less importance than the development of shale mining and refining; and that all the evidence available at present leads to the belief that an oil-shale industry has good prospects of proving successful.

Grading of Wattle Bark in South Africa. — In the last number of this Bulletin (p. 117) reference was made to the Government inspection of wattle bark in South Africa, and a list of the official grades was given. Since then it has been decided to amend the descriptions so that the first grade in each class is now called "choice" and the second grade "fair average quality." The classes for grading are now as follows: H. 1, Heavy (choice); H. 2, Heavy (fair average quality); M. 1, Medium (choice); M. 2, Medium (fair average quality); T. 1, Thin (choice); T. 2, Thin (fair average quality); B. G., below grade.

Insect Pests of the Southern Provinces, Nigeria.—Extensive tours were made in 1912 by the late Entomologist of the

Agricultural Department, Southern Provinces, Nigeria, to study the prevalent insect pests, and the results of these and of work done at headquarters are published in the *Bulletin of Entomological Research* (1913, **4**, 191), together with recommendations as to methods of dealing with the pests.

Cotton is attacked by many enemies, among which the red cotton stainer (*Dysdercus superstitiosus*) is the worst; it sucks the juices of the rich, oily seeds and stains the cotton lint with yellow excretory juices, doing an immense amount of harm both to the seed and to the lint. It feeds also on the silk-cotton tree, Hibiscus, and other plants, and so finds food all the year round. No natural enemies have yet been discovered. The remedies are: (1) Keeping the plantations clean and free from weeds and removing silk-cotton trees in their neighbourhood; (2) removing the insects from the plants by means of a net; this is suspended from a wire circle with a deep bend in it reaching to the centre, so that it can be fitted round the stem of the plant; (3) the employment of trap crops ripening earlier than the cotton; from these the stainers can be collected and killed: this plan, however, has not yet been tested; (4) gathering the cotton immediately it is ripe; (5) sunning it well when gathered and constantly turning it over; the stainers then crawl away and can be killed; (6) burning the old cotton stalks, as these, if left, harbour the pest. The native cotton plants reach a height of 6 ft. and more, and are wide-spreading; this renders some of the above methods hard to carry out. It is hoped that by selection for moderate size and a better yield of lint an improved native type may be obtained.

The black cotton stainer (*Oxycarenus Dudgeoni*) has not been so fully studied, and whether it stains the lint seriously is not yet known. It can be combated in the same way as the red cotton stainer. Three boll-worms, *Diparopsis castanea*, *Earias biplaga*, and *Chloridea obsoleta*, seem widely distributed throughout the country; the caterpillars bore into the unopened bolls and devour the seeds. These and the leaf-rolling caterpillars, *Sylepta derogata* and *Zebronia phenice*, might be destroyed by spraying, and by taking care to burn the old stalks and diseased bolls at the end of the season. Lead chromate is suggested as an easily handled and effective poison. The green fly (*Aphis gossypii*) is kept well in check by ladybirds and their larvæ, and by the larvæ of hover-flies, and lacewing flies, which feed on it. Certain beetles feed on the leaves of the cotton plant, but do not seem to be a serious pest; they should, however, be watched for, especially on young cotton, and spraying with lead chromate should be employed if circumstances warrant it.

Cocoa also received attention. *Diacrisia maculosa* is the worst of the caterpillars; it is very active, crawls quite long

distances, and has been frequently observed crossing from cocoa beds to maize, on both of which it feeds, as well as on kola and cotton. Maize and cocoa should therefore not be grown near together when this pest is prevalent. The pod borer is also a serious pest, and to check its ravages the wholesale clearing-up and destruction of neglected pods is essential. Red tree-ants (*Œcophylla smaragdina longinoda*), though they do not injure the cocoa trees, cause great annoyance to the cocoa gatherers by their irritating bites; they form leaf-nests, which should be cut down and destroyed.

Maize and grass are liable to be seriously attacked by swarms of caterpillars; these should be checked by examining the maize fields and lawns and their surroundings at the likely times for small young caterpillars, and if found the grass and bush round the fields should be burnt, and caterpillars on the maize and lawns should be destroyed by spraying. The mealie stalk borer of South Africa, *Calamistes fusca*, has been found, as also have Noctuid caterpillars, which attack the maize cobs; but these have not yet been fully studied in Southern Nigeria.

Maize, when stored, suffers greatly from the attacks of weevils and other beetles. As the natives often store maize in their huts on shelves above the cooking place, so that it is under the influence of the warmth and smoke, experiments were made to ascertain if this method possessed any practical value for storing cobs and seed on a large scale for food and the market, but the results were not encouraging, and fumigation by carbon disulphide is a far more efficient method. A fumigatorium is being built at Ibadan.

Insects affecting yams, rubber trees, mahogany and other plants were also studied; and the need of more pioneer research work is urged as being essential before reliable advice can be given to the native farmers as to methods of economic value for combating the insect pests.

Insect Pests of the Nyasaland Protectorate.—A list of insects collected or bred from various crops in Nyasaland during 1911–13, with some account of their economic importance, is given by the Government Entomologist in the *Bulletin of Entomological Research* (1914, **4**, 347). Cotton seems to be the worst sufferer, and to be attacked by a greater variety of insects than any other crop.

The larvæ or caterpillars of Lepidoptera (moths and butterflies) are the most destructive pests in the country, the three boll-worms doing a tremendous amount of damage. The red boll-worm (*Diparopsis castanea*), *Chloridea obsoleta*, and *Earias insulana*, occur all over the Protectorate, attacking cotton; the second also attacks maize, tobacco seed-pods, and chick-peas; and the third has been found on

garden Hibiscus. The cotton leaf-rolling caterpillar, *Sylepta derogata*, is rare in the Zomba district, but further north on the Lake shore it is a serious pest. *Euxoa segetum*, *Prodenia litura*, and *Phthorimæa heliopa* are serious pests on tobacco ; the second also attacks cotton and maize, and has been once found attacking tea. *Busseola fusca* causes great loss by boring in the stems of maize and millet. Mahogany plantations are stripped of their leaves by *Heteronygmia leucogyna*.

Of the Acridiidæ (grasshoppers and locusts) two species are troublesome, eating the leaves of the young tobacco plants in the nurseries ; these are *Maura bolivari* and a species of *Chrotogonus*.

Of the beetles (Coleoptera) a few are destructive ; among these are : *Lagria villosa*, on leguminous plants in vegetable gardens ; *Ootheca mutabilis*, to the flowers of native pumpkins, occurring also on cotton and leguminous crops ; *Pachytoma gigantea*, in cypress nurseries by eating the growing points of the young trees ; the larva of *Apion armipes*, boring in the stems of cotton plants, causing them to swell at the point of irritation and frequently to break at the first high wind ; and the grain weevil, *Calandra oryzæ*, here as elsewhere, is very destructive to stored maize and rice.

A saw-fly, a species of *Athalia*, is a major pest on turnips and cabbages. Several species of aphis are injurious, namely : *Aphis gossypii*, on cotton in certain seasons, especially those with excessive rainfall ; the bean aphis and the cabbage aphis (*A. brassicae*) ; this last is covered with a waxy secretion which makes it difficult to destroy by contact poisons.

Antestia variegata does considerable damage to coffee berries, and *Dysdercus nigrofasciatus* is a major pest of cotton, which it damages both by sucking the seeds and staining the lint.

Development of German Nyasaland.—An account of Lake Nyasa and German Nyasaland, written in response to the offer of a prize by the German Colonial Society, has been published as *Supplement* No. 10 (1914) of the *Mitteilungen aus den Deutschen Schutzgebieten*. The lake is situated in one of the long hollows characteristic of Africa, which lie deeply sunk in the high plateaus ; it is over 300 miles in length and about 30 miles in breadth, and runs almost due north and south. Half of its eastern shore and also the northern extremity belong to German East Africa. Although the surface is 1,570 ft. above sea level, it is so deep that its bottom in some parts is below sea level. At the northern end the land rises at first gently but afterwards steeply to a barrier of volcanic mountains. This district is known as Kondeland. On the eastern shore the rise is

rapid to a height above the lake surface of 3,500 ft. and more in the Livingstone mountains and the Matengo plateau. Portions of the mountain area are much higher than this, the highest parts being over 9,000 ft. above sea level. On the western or English shore the slope for the most part is much more gradual.

As a result of these variations in altitude the climate of different places varies greatly; thus the mean annual temperature of Ikombe, at the north end of the lake, is 75° F., and the monthly range is from 69° F. in July to 79° F. in November; whilst at Tandala, which is in the mountains not far from Ikombe, but 5,000 ft. higher, the mean annual temperature is 57·5° F. As regards rainfall the prevailing wind is from the south and south-east, and so the water vapour of the lake is brought with it and deposited as rain at the north end. Most of the rain in the Nyasa district comes in the summer, and generally speaking there is little in winter. In Kondeland the annual fall is always above 40 in. and often 80 in. and more, whilst the south coast of the lake and the Shiré valley generally receive 40 in. or less. The western side of the lake also receives more rain than the eastern.

There are now three elements in the population of Nyasaland, namely: (1) the natives belonging to the various tribes; (2) immigrant coloured races, Arabs, Indians, and Swahilis, differing essentially from the natives in their customs; and (3) Europeans.

The natives formerly produced only what was wanted for their own needs—any store of goods would have excited the greed of robber tribes; but now that they are protected under German rule, they have new opportunities for marketing their produce. Agriculture and cattle raising, and, to a less degree, hunting and fishing, are their chief industries. They grow maize, rice, and various millets such as sorghum and ragi (*Eleusine coracana*), manioc or cassava, and sweet potatoes; in the mountainous parts beans and peas, and plantains in Kondeland. The bamboo is grown for its sap, from which an intoxicating drink is made. Since 1905 wheat and potatoes have been introduced by the missionaries and have been readily adopted, displacing other crops to some extent. There has been quite a large sale of wheat, and some has even been exported to British Nyasaland. Some of the natives find employment as servants to the Europeans, as clerks in the Government service, and as teachers with the missionaries. There are scarcely any large plantations employing many natives, as there are in Usambara in the north of German East Africa. A small percentage, however, leave their homes and seek employment on the roads or on railway building or on the coast.

The number of coloured immigrants is not large; most

of the carrying trade is in their hands, but they take scarcely any part in production, though some Arab planters grow rice and sugar-cane with slave labour in the low-lying part of Kondeland.

The white population is made up of German officials and officers who live at the centres of government; of missionaries who try to grow the supplies necessary for their stations, and beyond that do not produce very much; and lastly there are a few German settlers and some small plantations, but their output is still unimportant. The largest of these, a rubber plantation at Kjimbila, has not yet exported much rubber. Cattle-raising has been the most successful undertaking for the settlers; they also grow rubber, coffee, tea, rice, and sugar-cane.

As regards minerals, coal occurs between Ssongwe and Kiwira, and possibly can be worked profitably when transport facilities to the coast are more favourable. The seams are connected with the sediments of the Karroo formation; they have not been formed *in situ*, so some caution is necessary in estimating their value. There are also large beds of iron ore in the Livingstone mountains, and rich copper ore has been found on the borders of Buanji and Ussangu.

To open up the country the Government has made a network of roads with a view to joining up the different parts of Nyasaland among themselves and with other districts. Further transport facilities to the coast, however, are needed, and railway communication with the coast would make Nyasaland one of the most desirable places of settlement in German East Africa and cause its rapid development. At present transport by carriers from Wiedhafen on the lake to Kilwa on the coast takes about thirty-one days. A southern line from Wiedhafen to Kilwa, or else a branch line from the existing central railway, starting at or near Kilossa, has been thought of, the latter line being most favoured at present.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the Bulletin *a summary is given of the contents of the more important papers and reports published during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India, and the Tropics generally.*

Soils and Manures

The relationship between the natural vegetation and the capabilities of the underlying soil for crop production, is discussed, with special reference to the Tooele Valley,

Utah, in *Journ. Agric. Research* (1914, **1**, 365). The sage bush (*Artemisia tridentata*) was found to characterise light permeable land, which had a rather low moisture-retaining capacity and was free from large amounts of alkali salts. A good growth of sage bush, as a general rule, indicated land well suited to dry or irrigation farming. On the other hand, a poor stand usually showed on land too poor for profitable cultivation.

Where the Kochia (*Kochia vestita*) type of plants occurred the land was of finer texture and had a higher moisture-retaining capacity than that on which sage bush was growing. Although the first foot of soil was usually fairly free from alkali salts, the subsoil contained a fairly large percentage, and on this account dry farming is stated to be somewhat precarious on this land. Where the shadscale (*Atriplex confertifolia*) type of vegetation occurred land somewhat similar to that occupied by the Kochia type was found, but the content of salts was lower, and as the soil is more permeable, irrigation farming might be possible. Land on which greasewood (*Sarcobatus vermiculatus*) and shadscale were dominant differed from any of the foregoing in being moister during the summer months. It contained much saline matter below the first foot and often also in the top soil. Land of this type, if well drained, might produce good crops under irrigation.

The presence of grass-flat vegetation, of the type of *Sporobolus*, *Distichlis*, or *Chrysothamnus*, was found to indicate land of high moisture content, more or less saline and not suitable for cultivation unless drained. Salt-flat vegetation, such as *Allenrolfea* or *Salicornia*, indicated that the land was extremely saline and not adapted for crop cultivation.

In view of the attention which is being paid to the practice of heating soils as a means of increasing their fertility, a recent paper on "The Effect of Heat upon the Mineral Constituents of the Soil," in the *Journ. Indust. and Eng. Chem.* (1914, **6**, 223), is of interest. The soils selected for experiment were 12 typical Hawaiian samples, and heating was performed in three stages, viz. (1) up to 100° C. for 8 hours; (2) up to 250° C. for 8 hours; (3) ignition over a Bunsen flame. Extracts were made, from each of the samples treated as above, with both water and fifth-normal nitric acid, 5 parts of solvent being used to one of soil. The results for the various mineral constituents may be briefly summarised as follows:

The solubility of the lime and magnesia in water increased with the temperature employed up to 250° C., but a decrease took place on ignition. Nitric acid extracted the largest quantity of lime and magnesia from the samples heated to 100° C., whilst those ignited showed the least solubility.

The phosphates were most soluble, in nitric acid, after ignition; but those heated to 100° C. or 250° C. showed the greatest solubility in water. It is interesting to note that the phosphates in the uncultivated soils were found to be more soluble than in those under cultivation. Potash was found to be most soluble in soils heated to 250° or ignited, the average being in favour of the latter. Contrary to what was found in the case of the phosphoric acid, cultivated soils were found to contain more soluble potash than uncultivated.

Heat produced a striking change in the solubility of the sulphates, heating to 250° C. producing the form most soluble in water, but ignition caused a decrease in the solubility. The largest amount of sulphate was extracted, by nitric acid, from the ignited samples. In many cases, the sulphates were more soluble in water than in nitric acid.

An account of the present condition of the phosphate fields of South Carolina is given in *Bulletin* No. 18, *U. S. Dept. Agric.* These deposits, which have been worked since 1868, still contain enormous quantities of phosphate averaging 61 per cent. of calcium phosphate. Owing to the increased cost of production, which now averages $3·46 per ton, the material cannot be profitably exported and is therefore used locally for the manufacture of "acid phosphate." The increased cost of production has been largely occasioned by the greater quantity of useless overburden, which has now to be removed before the workable phosphate is reached.

Experiments have been carried out, in Java, over a period of four years, in order to determine the suitability of various plants for use as green manures and cover crops. In all, some 53 species were tried, and from the results of the experiments, which are quoted in *Mededeelingen uit den Cultuurtuin*, No. 1, 1913, *Departement van Landbouw, Nijverheid en Handel, Java*, six of these are recommended for use. *Leucaena glauca*, Benth., which has given great satisfaction, may be planted at any altitude from sea level to 3,500 ft. It requires a fairly good soil and produces plenty of seed, but not more than 50 per cent. of this will germinate after keeping for 4 months. It is not of much service as a cover plant, as its leaves soon fall off. *Clitoria cajanifolia*, Barth., was found to be one of the most suitable plants as a cover; the leaves are very tough and are not eaten by animals. It grows best at lower elevations than 2,000 ft., and is very suitable as a shade for coffee or Hevea. *Tephrosia candida*, *T. Vogelii*, and *T. Hookeriana* have the advantage over the foregoing in that they will grow well on a much poorer soil. *T. Hookeriana* can be cut back several times at intervals of 5 months, but the old plants suffer from a stem disease. *T. candida* grows more vigorously than the last mentioned and is able

to withstand considerable drought. It is a good cover crop and excellent as a green manure. *Desmodium gyroides*, DC., is the most valuable of the Desmodium species, and grows in a bushy form producing many leaves. It appears to be rather subject to attack by a fungoid disease, *Corticium salmonicolor*, after being pruned a few times.

Some interesting results obtained by spraying fruit trees, during the dormant season, with solutions of sodium nitrate are given in *Journ. Agric. Research* (1914, **1**, 437). It had been observed previously that the rest-period of a number of woody plants was materially shortened by treating their dormant shoots with nutrient solutions, and the experiment was tried of treating apple and pear trees in certain orchards in California with solutions of sodium nitrate and caustic potash, the latter being added for its insecticidal properties.

The mixture used, which consisted of 50 lb. of sodium nitrate and 7 lb. of caustic potash to each 50 gallons of water, was applied at the rate of 7 gallons of solution per tree, care being taken that all the small twigs were thoroughly drenched. Check trees were selected, and were either untreated or had 50 lb. of sodium nitrate applied *as a manure.* It was found that the sprayed trees blossomed about two weeks earlier than the check trees, and there was a marked improvement in the colour, abundance, and vigour of the foliage.

The experiments have only been continued over two seasons, but the results indicate that, in the case of certain varieties of apples and pears, an increased yield is obtained by winter spraying with sodium nitrate and caustic potash. The authors point out, however, that there would be some danger of injury from frost in the case of trees forced into bloom earlier than usual.

A further account of the results of the manurial experiments which are being carried out in certain German Colonies (cf. this BULLETIN, 1913, **11**, 522) is given in Nos. 2, 3, and 4 of *Dungenversuche in den Deutschen Kolonien* (German Colonial Office, 1913). Full details are given of the experiments on the economic plants cultivated in Kamerun and Togoland (No. 2), German East Africa (No. 3), New Guinea and Samoa (No. 4).

FOODSTUFFS AND FODDERS

Maize.—According to the *Rep. Dept. Agric., Union of South Africa*, 1912–13, p. 157, the following definite breeds of maize have been produced: (*a*) An earlier-maturing "Hickory King"; (*b*) an improved-grain type of early maize; (*c*) some drought-resistant types; (*d*) a promising type, comparing favourably with the high-priced Bessarabian and South-east European types. These types are now being fixed, a process which requires three to five seasons to complete,

An account is given in *Journ. Agric. Research* (1914, **1**, 293) of the study of the type of maize grown by the Hopis and other agricultural Indians of New Mexico and Arizona. The type possesses two special characteristics, which enable the corn to succeed in dry regions, namely: its ability to force the growing shoot to the surface of the soil when planted at the depth of a foot or more, and the development of a single large radicle that rapidly descends during the critical seedling stage to the moist subsoil.

The Pueblo Indians have strains sufficiently productive to compare favourably with improved varieties, even when grown under irrigation. Experiments are suggested to determine the possibility of utilising this type of maize in semi-arid regions.

Wheat.—The results of experiments with wheat at the Lyallpur Agricultural Station are given in Appendix No. VI. to *Rep. Dept. Agric., Punjab*, 1912–13, and show that hot-weather ploughing is more beneficial than ploughing during the rains. It was found that the use of calcium nitrate as a manure produced increased yields, but only in one plot in four was the application profitable. It was, in that case, applied at the rate of 168 lb. per acre. Further trials with wheat No. 9 indicate that it produces large yields only on good land, and yields better when sown after cotton than when it follows wheat.

Sugar.—The results obtained by a mission specially appointed to investigate the froghopper pest in Trinidad are contained in *Bulletin Dept. Agric., Trinidad and Tobago* (1914, **13**, 45). The following recommendations are made and discussed: (1) A search should be made for efficient parasites of the eggs or adult form of the froghopper. (2) The Syrphid fly should be put on to the early broods of froghoppers. (3) Abandoned lands adjacent to cane fields should be either put under a cover crop or grazed. (4) Trash should be removed from the field, and not returned till well broken up and sodden. (5) As soon as early broods of froghopper nymphs appear, they should be destroyed by hand picking; the early adult broods should be destroyed by kerosene-lysol emulsion, or by squeezing the leaf-sheaths. (6) The later large swarms of adults should be destroyed, as far as possible, by trap-lights.

Teosinte.—The cultivation of teosinte (*Reana luxurians*) as a fodder plant is described in the *Cyprus Journ.* (1914, No. 32, p. 741). If irrigated, the plant yields three or four crops per season, amounting to 75 to 90 tons of green fodder per acre. It is readily eaten by cattle.

Oils and Oil Seeds

Coconuts.—The results of experiments in the cultivation of coconuts on irrigated and non-irrigated land at Maha-

illuppallama in the North-Central Province of Ceylon have been published (*Bulletin* No. 7, 1913, *Dept. of Agric., Ceylon*). The principal object of the experiments has been to determine whether the trees will thrive when dependent on natural rainfall helped out by a minimum of irrigation during severe drought, irrigation being supplemented by thorough cultivation with modern cultivating machinery. The experiments are not completed yet, but have already indicated that coconuts will do very well in this district under irrigation with a reasonable amount of cultivation; on unirrigated land which was not cultivated the palms did not thrive, and have been very susceptible to attacks of red beetles (*Rhyncophorus signaticollis*).

The coconut palm is only grown in Burma as a garden tree and not on a large plantation scale, although there is abundant land suitable for coconut cultivation in the coast districts and surrounding islands. The questions of soil, methods of cultivation, and maintenance of plantations are discussed by Sawyer in *Bulletin* No. 11, 1913, *Dept. of Agric., Burma*. Special attention is given to methods of draining and the formation of new plantations.

The cultivation of coconuts on the west coast of Borneo is described in *De Indische Mercuur* (1913, **36**, 1971). Details of cost of establishing and running plantations are also given.

An increased number of coconuts was exported from Dominica in 1912, although not much attention appears to have been paid to planting recently (*Rept. Agric. Dept., Dominica*, 1912–13, p. 17). Fairly large areas of land suitable for coconuts are available. The trees probably flourish best in valleys near the sea on the westward side of the island, where the rainfall is over 100 in. per annum. As yet no diseases have been noticed.

Advantage is being taken by planters in the Panama district of the large amount of labour set free by the completion of the Canal (*Phil. Agric. Rev.*, 1914, **7**, 38), and land for coconut and fruit planting is being bought up rapidly.

The present conditions and possibilities of coconut planting in tropical America are discussed briefly in the *Tropical Agriculturist* (1913, **41**, 374). The coconut palm grows well throughout Central America and the tropical regions of South America.

The palm weevil (*Rhyncophorus palmarum*) is stated to be on the increase in St. Vincent (*Rept. Dept. Agric., St. Vincent*, 1912–13, p. 13). This is probably due to the destruction of the gru-gru palms (*Acrocomia* sp.), which are being removed in clearing areas for cotton planting. The gru-gru palms are often destroyed by merely chopping cuts in the trunks; the larvæ of the beetles develop in these cuts and kill the tree. It seems only reasonable to

suppose that with the removal of the gru-gru palms the beetles will transfer their attention to the coconut palms.

In British Guiana the larvæ of a nocturnal moth, *Castnia dædalus*, Cramer, have caused damage to coconut palms (*Journ. Bd. of Agric., Brit. Guiana*, 1913, **7**, 87). The larvæ measure up to 4 in. in length and burrow between the leaf bases and the trunk, causing the branches to drop off and producing longitudinal furrows on the trunk; in cases of severe attack the trunk is weakened to such an extent that it breaks when subjected to strong gusts of wind. Trees should be examined periodically and the lower branches of attacked trees should be cut away until the larvæ are found and destroyed.

Serious damage to coconut plantations in Samoa is being caused by the rhinoceros beetle (*Oryctes rhinoceros*, L.). The distribution of this pest, its natural enemies, and the means of destroying it are fully discussed by Friederichs in *Der Tropenpflanzer* (1913, **17**, 538, 603, 660). The most effective method appears to be the formation of traps for the larvæ, composed of heaps of decaying wood and cocoa husks; the beetles are attracted by the smell of the decomposing cocoa husks, and lay their eggs in the heaps; the larvæ can then be destroyed when the heaps are turned over periodically. The most important point in this article appears to be the discovery of a fungoid disease which attacks the larvæ and kills them. This fungus, *Metharrhizium anisoploe*, can be used to inoculate the heaps of rubbish in which the beetles lay their eggs, and the larvæ which hatch out are then infected and die. Trials with this fungus have proved the practicability of this scheme, which is favourably spoken of by the manager of one of the large plantations and is being taken up by planters.

Ground Nuts.—According to the *Indian Trade Journal* (1914, **32**, 199) the total area under ground nuts in the ryotwari villages of the Madras Presidency in 1913 was 751,200 acres, an increase of 19·1 per cent. on the area reported as sown during 1912. Exports of ground nuts from the ports of the Presidency show a steady increase, and during 1912–13 amounted to 316,548 tons. It is stated that 80 per cent. of the shelled ground nuts imported by Marseilles are from the Coromandel coast, and the average area under ground nuts in the Madras Presidency during the five years ending 1911–12 has represented 70 per cent. of the total area under ground nuts in British India. The ryots are stated to be abandoning other crops for ground nuts on the dry lands, but are at present hampered by lack of decorticating machinery. In view of the steady increase in the exports of ground nuts, a scheme has been outlined by the Chairman of the Madras Port Trust Board for the provision of additional storage and other facilities for the ground nut trade at Madras.

According to *Der Tropenpflanzer* (1914, **18**, 49) an agreement has just been concluded between the Belgian Government and an Antwerp firm for the leasing of 40,000 hectares of land in the Belgian Congo. The Company is to be allowed its own choice of territory, but is bound to utilise the land for the cultivation of ground nuts and maize, and is further required to show yields of 125, 250, and 500 kilograms per hectare of seed or grain by the end of 1920, 1928, and 1938 respectively. On the expiration of the contract in 1942 the land is to become the property of the Company at a rental of 25 centimes per hectare, provided that the yield of 500 kilograms per hectare is maintained. The capital of the Company is 3½ million francs.

An account is given in *L'Agricoltura Coloniale* (1914, **8**, 171) of experiments which have been made in Italian Somaliland with varieties of ground nuts, from which it appears that the most satisfactory yields of both kernel and oil were obtained from the Haut-Saloum and Gambia varieties.

Oil Palm.—According to Amman (*L'Agronomie Colon.*, 1913–14, **1**, No. 7, p. 9) the soil of Gaboon is very favourable to the growth of oil palms, an average yield of 220 lb. of fruit-heads per tree in a year being obtained. The author states that the fruits are larger than those grown in any other part of Africa. The average weight of a fruit in one sample was 11·2 grammes—from the analytical figures given it is evident that the fruits were almost dry; but allowing for this fact, the average weight is close to but does not exceed that of a sample of the "Ak-por-ro-jub" variety from Nigeria examined at the Imperial Institute, the fruits of which had an average weight of 12·8 grammes in a moist condition (cf. this BULLETIN, 1909, **7**, 377).

Interesting details concerning the yields of fruit, palm oil, and kernels obtainable from palms in Lower Guinea are given by Nicholas (*L'Agronomie Colon.*, 1913–14, **1**, No. 5, p. 138). The crop obtained during a whole year was weighed, the fruit being harvested in October 1911, and in January and May 1912. A group of 590 trees yielded 2,521 bunches of fruit. The total weight of the fruit bunches was 44,220 lb., and they yielded 22,511 lb. of fruit, the average weight of a fruit-bunch being 17½ lb. The yield of palm oil by the usual native methods was 2,068 lb., equivalent to 8·1 per cent. by weight of the fruit. The yield of kernels was 4,519 lb., equivalent to 17·7 per cent. of the fruit.

According to Hallet (*Journ. d'Agric. trop.*, 1914, **14**, 31) the oil palm grows well in Malaya. In a small plantation of 150 trees five to six years old, each tree is stated to have borne from 200 to 300 kilograms (440 to 660 lb.) of fruit—this is presumably a misprint for 20 to 30 kilograms; the trees reach the full bearing period by the sixth year.

According to researches carried out by Elsdon (*Analyst*, 1914, **39**, 78), palm-kernel oil very closely resembles coconut oil, and no certain means were found of distinguishing these two oils. The results of the investigation are open to criticism, as the specimen of palm-kernel oil used was not extracted from palm kernels by the author, but was purchased, and may therefore not have been genuine unadulterated oil.

Tung Oil.—Experiments are in progress in the West Indies in growing *Aleurites Fordii* (*W. I. Agric. News*, 1913, **12**, 403). The seeds were obtained from Foochow through the Botanical and Forestry Department, Hong Kong, and were distributed to Antigua, St. Kitts, Montserrat, Dominica, and St. Lucia. In all the islands germination and early development were satisfactory, but on being planted out in the field at low elevation very little progress was made. As the trees thrive best on dry and rocky hillsides (cf. this BULLETIN, 1913, **11**, 448), a few plants are at present under trial in the Dominica hills, although it is feared that the rainfall may prove too heavy. Apparently the tree has shown more promise in St. Kitts, as forty plants have been raised in the nurseries and are being distributed in the Presidency.

Miscellaneous.—Fruits of the Sagdo tree, obtained from the Ngaundere district, Kamerun, yield kernels containing 45 per cent. of oil, equivalent to about 20 per cent. on the whole fruit. The analytical constants of the oil are given in *Chem. Rev. Fett u. Harz Ind.* (1914, **21**, 57). The oil is non-drying and possesses a bitter taste which would render it unsuitable for edible purposes. According to a commercial firm, however, the oil is suitable for the manufacture of soap.

Results are given (*loc. cit.*) of the examination of seeds of *Melampyrum arvense*, which are used extensively as an adulterant of Russian linseed and hemp seed. The seeds contain 35 per cent. of a somewhat viscous oil which exhibits no drying properties and is liquid below 0° C. The analytical constants of the oil somewhat resemble those of castor oil, suggesting that it might be used technically as a substitute for the latter.

Seeds of *Hibiscus cannabinus* ("Da") contain 20 per cent. of a bright yellow drying oil, capable of being used for the manufacture of linoleum and varnishes (*L'Agronomie Colon.*, 1913–14, **1**, No. 6, p. 161). The samples examined were grown in the Niger valley and Upper Senegal, and it is stated that under normal conditions a yield should be obtained of about 500 kilos. of seeds per hectare.

Seeds of *Sinapis juncea* are stated to yield a fatty oil suitable for use as an edible oil (*Chem. Rev. Fett u. Harz Ind.*, 1914, **21**, 85).

According to *Der Tropenpflanzer* (1913, **17**, 710), the fruits of *Camellia japonica* yield an oil capable of being used as a lubricant or for the manufacture of soap. The article states that the tree is grown principally in Kiushiu and the surrounding islands, and also in the Idzu Islands, to the south of the Bay of Tokio. Oil to the value of about £10,000 was exported in 1911, it is said principally to Great Britain and China, but it is thought that exports will increase greatly when the oil becomes better known.

Essential Oils

Bay Oil.—As the result of investigations conducted over a period of two years in Montserrat, the *Rep. Bot. Station and Expt. Plots*, 1912–13, states that the cultivation of the bay tree could be developed probably as a small industry. Monthly distillations were carried out to determine the best time for picking the leaves, and experiments made to ascertain whether the export of the dried leaves or oil would prove more profitable. A study of the differences in yield and quality of oil from selected trees seemed to indicate that selection would lead to improved results.

The amount of bay oil and leaves exported from the island in 1912 was 43 gallons and 12,289 lb. respectively; these exports were derived from uncultivated forest trees.

Star-anise Oil. — The *Journ. d'Agric. trop.* (1914, **14**, 40) contains an article on the star-anise oil industry of the Langson district of Tonkin, the area from which two-thirds of the star-anise oil imported into Europe is derived (see also this Bulletin, 1913, **11**, 159). The star-anise tree (*Illicium verum*) flourishes best in that part of Tonkin which has a moist and somewhat variable climate, and especially on hill sides with a red clay-schist soil. The seeds are said to lose their power of germination rapidly, and the Chinese preserve them in layers of dry earth. The plants should at first be well sheltered from the sun, and then require a great deal of attention until the eighth or tenth year. The fruit appears between the tenth and fifteenth year, and during a period of 20 to 35 years the trees are in their prime, and should produce two crops a year. Five tons of green fruits per hectare (2·47 acres) is stated to be a good yield for a mature plantation. Mention is made of the diseases and insect pests to which the tree is subject. In the event of a bad crop of fruits the natives are now beginning to distil the leaves, which yield about a tenth as much oil as the former. Although the leaf oil has not quite the same characters as those of the fruits (cf. this Bulletin, *loc. cit.*), it is stated that local buyers do not discriminate between them. The yearly production of oil from Tonkin is variable. The output in 1910 was 66 tons, rising to 100 tons in 1911, and falling again to 46 tons in 1912.

Turpentine Oil.—Experiments on the utilisation of tree stumps and mill-waste by distillation (cf. this BULLETIN, 1909, **7**, 73; 1911, **9**, 421) have been conducted recently in Canada and in the United States with wood obtained from the Douglas fir (*Oil and Colour Trades Journ.*, 1914, **45**, 383). By steam distillation the best result obtained was 4·1 gallons of turpentine oil per "cord" of wood, weighing 3,800 lb. By destructive distillation the average yields obtained per cord in two test runs were wood alcohol 100 per cent. strength, 2·3 gallons; turpentine oil, 1·6 gallons; other oils, 3·8 gallons; tar, 15·3 gallons; acetate of lime (80 per cent. strength), 62·9 lb.; charcoal, 800 lb. It is stated that as these proportions of turpentine and other oils, and tar, are lower than those commonly obtained from waste wood of the Norway and long leaf pines, the use of Douglas fir wood on a large scale for distillation purposes is not anticipated.

RUBBER

Hevea brasiliensis.—Results of work by Bateson on the food reserves of Hevea trees are summarised briefly in a report on Agriculture in Malaya in 1912 (*Bulletin* No. 18, 1913, *Dept. Agric., Federated Malay States*). The work was not completed when the report was published, but the results already obtained indicated that (1) Normal tapping does not cause such a depletion of starch reserve as to necessitate more conservative systems of tapping, with regular periods of rest; (2) Tapping on adjacent quarters seems more favourable to the tree and also more advantageous than tapping on opposite quarters; (3) Defoliation during "wintering" caused marked diminution of starch, but the facts observed did not point to the necessity of resting trees during this period.

Three and a half year old Hevea trees are making satisfactory growth, and are in healthy condition at Kampala, Uganda (*Ann. Rept. Dept. Agric., Uganda*, 1912–13, p. 11). The trees average a little over 6 in. in girth at 3 ft. from the ground; a number measure between 6 in. and 9 in., but none are large enough yet for tapping.

Hevea seed and young plants are much in demand by natives in the Gold Coast (*Rept. Agric. Dept., Gold Coast*, 1912, p. 15). Small isolated plantations are being made all over the country, but it will be some years before much rubber can be produced. A number of plantations have been made by Europeans in the Colony, and on some of these tapping has been started and rubber from them has been sold.

Spring has carried out (*Agric. Bulletin, Fed. Malay States*, 1914, **2**, 146) some experiments to ascertain the value of tapping by gouge in the usual way as compared with "pricking" with a Northway four-point serrated knife. Fifty four-year-old trees were tapped by each method

on the quarter system. The yield of rubber over a period of six months was practically the same in each case; no injury was done to trees by the Northway serrated knife, but the cost of labour in using it was about double that of tapping with the gouge.

In Ceylon a beetle, *Mæchotypa verrucicollis*, Gahan, has been found to attack young Hevea plants (*Trop. Agriculturist*, 1914, **42**, 41). The plants attacked were mostly stumps which had withered, and which probably would not have grown. Spraying with lead arsenate is recommended.

Although "black scale" (*Lecanium nigrum*) is not considered a serious pest to Hevea trees in Ceylon at present, Rutherford (*loc. cit.*) recommends that it should be destroyed whenever possible, as it may become serious.

Manihot species.—Although *M. dichotoma*, *M. piauhyensis*, and *M. heptaphylla* have made rapid growth at the Government Plantation, Kampala, Uganda (*Ann. Rept., Dept. Agric., Uganda*, 1912–13, p. 11), they can only be grown in sheltered positions, as all the trees have suffered severely from storms. The claim that these species are less liable to damage by wind than *M. Glaziovii* appears to be incorrect.

Zimmermann gives the results of examination of a number of samples of Manihot rubber prepared by various methods in German East Africa (*Der Pflanzer*, 1914, **10**, 67). Most of the samples were valued in Germany by brokers, and also tested technically. The results, which are of particular interest at the present time, when so much attention is being given to vulcanisation tests (cf. this BULLETIN, 1914, **12**, 76), show that brokers' valuations, based on the appearance of the raw rubber, are of little value as indications of the real value of the rubber for technical purposes. A point which is very strongly brought out is the uselessness of attempting to ascertain the technical value of a series of samples by curing every sample for the same length of time; it is necessary to ascertain by experiment the correct time of cure for each specimen. Thus, two similar samples, A and B, gave figures for tensile strength of 20 and 44 kilograms per square centimetre respectively when cured for two hours; but when A was cured for 2 hours 40 mins. its tensile strength rose to 41. The results show that Manihot rubber of excellent quality may be prepared by the Lewa method, or by coagulation with calcium chloride.

Ficus species.—Descriptions of the different species of *Ficus* occurring in the Belgian Congo are given by de Wildeman (*Bull. Soc. Roy. Botan. Belgique*, 1913, **52**, 196).

The different species of boring insects attacking *Ficus elastica* are described by Dammerman (*Mededeelingen van de Afdeeling voor Plantenziekten*, No. 7, 1913, *Dept. Landbouw Nijverheid en Handel, Java*).

Guayule.—Examination of three specimens of *Parthenium argentatum*, grown in Mexico in localities where different conditions of rainfall obtain, has been made by Lloyd (*Journ. Soc. Chem. Ind.*, 1914, **33**, 107). The results showed that wild guayule plants grown in districts with an abundant rainfall resemble plants grown under irrigation in containing less rubber than those growing under desert conditions. The amount of resin secreted does not seem to be affected by the quantity of soil water available, and no evidence was obtained to show that rubber and resin secretion are related.

General.—Trees of *Mascarenhasia arborescens*, 4 to 6 in. in diameter, have been tapped in Mauritius (*Ann. Rept. Forests and Gardens, Mauritius*, 1912, p. 14), but a very poor yield of rubber was obtained.

Dubard and Eberhardt state that the rubber of *Tabernæmontana annamensis*, a plant abundant in certain parts of Annam, is resinous, but that when de-resinified it is of good quality (*Journ. d'Agric. trop.*, 1913, **13**, 382). Two rubber vines (*Parabarium* spp.) also occur in Indo-China and are stated to yield rubber of fair quality, but no information is given as to the possibility of exploiting these species.

A simple pricking instrument has been devised by Ledeboer (*India Rubber Journal*, 1914, **47**, 520). It may be described as a number of needles mounted in a wooden handle. No results of trials with the pricker are yet available, but it is simple, and in the hands of unskilled coolies would probably be less likely to damage trees than more complex prickers.

From the results of experiments carried out by Marquis and Heim (*Bulletin de l'Office Col.*, 1913, **6**, 406), it is stated that one of the causes of tackiness of rubber is the absorption of atmospheric oxygen, a very small quantity of which appears to combine with the rubber; the tendency to tackiness is said to be entirely absent in smoked rubbers.

The results of researches carried out by Stevens on the influence of nitrogenous substances and resins on the vulcanising properties of rubber (*India Rubber Journal*, 1914, **47**, 403) controvert the often-quoted statement of Weber, that rubber freed from resin will not vulcanise. Stevens finds that the removal of resin does not prevent vulcanisation, but that vulcanised rubber made from resin-free rubber deteriorates rapidly on keeping.

Fibres

New Zealand Hemp.—It is stated in the *Annual Report of the New Zealand Department of Agriculture, Industries and Commerce for* 1913, that the high prices ruling for New Zealand hemp on the London market in that year gave

an impetus to the industry and encouraged owners of phormium estates and hemp millers to re-establish operations in districts in which, owing to the scattered nature of the plants, the business had for several seasons been unremunerative. Unfortunately the plants in the principal phormium-growing districts were attacked by a leaf-disease, and efforts are being made to find a remedy for this affection. Some of the hemp exported was of high quality, but much inferior fibre is still produced owing to the use of old-fashioned machinery. The demand for the higher grades was in excess of the supply. The exports in 1912–13 amounted to 120,452 bales of hemp, 41,036 bales of tow, and 7,777 bales of "stripper-slips," as compared with 85,684 bales of hemp and 23,433 bales of tow in 1911–12.

Sisal Hemp.—According to the *Report for* 1912–13 *on the Trade and Commerce of the Territory of Hawaii* (*Dipl. and Cons. Reps.*, No. 5,253, *Ann. Ser.* [Cd. 7048–70]) the area under Sisal hemp amounted to 1,800 acres, and the crop was estimated at 1,000 bales, each of 600 lb. The fibre is of excellent quality and is whiter and more valuable than the Mexican product. The exports for 1912–13 were 325 tons, of value £9,212. The growth of the plants has been retarded by a severe drought in the lowland plantations, and in consequence a decline in the production has occurred. In the upland districts, however, excellent results have been achieved.

Cotton

Egypt.—Reference has been made in this Bulletin (1913, **11**, 354) to the damage which has been caused in Egypt by the pink boll-worm (*Gelechia gossypiella*). During 1913 this insect caused more damage than all the other cotton pests together. Experiments have been carried out by the Ministry of Agriculture on methods of destroying the pink boll-worm, and an account of these is given in the *Agric. Journ. of Egypt* (1913–14, **3**, part 2, p. 73). It was found that it is necessary not only to fumigate the cotton seed, but also to destroy the hibernating worms in the bolls left on the stalks standing in the field and stacked for fuel, and it was also considered desirable to fumigate the ginneries and cotton seed stores at the close of the ginning season. Various methods of destroying the larvæ in cotton seed were studied, and the three following were found to be effective and applicable commercially. (1) Treatment with hot air at a temperature of about 80° C.; (2) fumigation with carbon disulphide, hydrocyanic acid, or sulphur dioxide; (3) immersion in "Cyllin" solution (0·1 per cent.) for 24 hours. The first two methods can be applied on a large scale at the time of ginning, and the third only immediately before sowing. No treatment is of avail when the seed is in sacks, owing to the difficulty of penetration. In the same

publication (p. 103) a description is given of a parasite of the pink boll-worm. The larvæ of this insect (*Pimpla roborator*, Fabr.) resemble fly maggots and are found in cotton seeds excavated by the pink boll-worm, lying beside the boll-worm and parasitic on it. Reference is also made (p. 127) to experiments carried out with the object of converting the cotton stalks into charcoal, and thus utilising the stalks whilst simultaneously destroying the pink boll-worm; it is shown that such charcoal can be sold at a price which more than covers the cost of its manufacture.

India.—The experimental work carried out at the Agricultural Stations in Bombay continues to make good progress. In the *Ann. Rep. Dept. Agric., Bombay Presidency, for the year* 1912–13, it is stated that a pure variety of "roseum" cotton has been selected, which is much superior in yield and ginning percentage to the other types constituting the mixture grown at Khandesh. It matures early, and the bolls open well and uniformly. Seed of this variety, sufficient for 352 acres, has been distributed to some of the best cultivators. The distribution of imported Navsari seed in the vicinity of Dharwar has been continued, and the crops have realised much higher prices than the local Kumpta. Cambodia cotton was grown extensively near Gadag, and, in spite of an unfavourable season, large quantities of cotton were obtained and realised good prices. An investigation has been undertaken at Gadag with a view to improving the Dharwar American cotton, which is composed of two distinct varieties, Upland Georgian and New Orleans. The seed of these varieties has been separated, and experiments are being made to determine whether the deterioration in yield and quality of the Dharwar cotton is due to its being a mixture. Cambodia cotton gave good results in North Gujerat, and in one case a crop of 1,592 lb. of seed-cotton per acre was secured. On the Jamrao Canal in Sind considerable success has been obtained with "Triumph" American cotton.

An account of recent work in the Punjab is given in the *Report of the Operations of the Dept. Agric., Punjab, for the year ending the 30th June*, 1913. Several strains of American cotton have been obtained which give large yields and good staple. American cotton is now established firmly in Lyallpur and Jhang, and will probably succeed also in Shahpur. The progress made with the indigenous cottons has not been so satisfactory, but experiments are being conducted to ascertain which type in each of the local mixtures is most profitable and to effect its cultivation in the particular locality.

In the *Report on the Operations of the Dept. Agric., Madras Presidency, for* 1912–13, it is stated that efforts are being continued to improve the cottons by selection with respect to the quality of lint, the ginning yield, and the

yield per acre. At Koilpatti an attempt is being made to secure a strain of Karunganni cotton which will ripen rapidly and thus be suitable for North Tinnevelly, where the season is not usually favourable for ordinary Karunganni, and promising results have been obtained. At Hagari and Nandyal new strains have been produced which give a higher ginning yield and cotton of a better colour than the usual varieties.

West Indies.—An account of the cotton industry in the St. Kitts-Nevis Presidency is given in the *Report on the Botanic Station, St. Kitts-Nevis*, 1912–13. The total area planted amounted to about 5,500 acres, or 900 acres more than that of the previous year. Of 2,000 acres devoted to the crop in St. Kitts, 1,350 acres were planted as an intermediate crop with sugar-cane. This practice has proved very profitable, and it has been found that the crop of cotton taken from the land does not adversely affect the subsequent cane crop; in fact, it is claimed that the good cultivation and tillage of the cotton plants cause the returns from the canes to be above the average. The cotton realised prices ranging from 1*s.* 6*d.* to 1*s.* 8*d.* per lb. The area planted in Nevis was 2,500 acres, an increase of 500 acres over that of the previous season, but the crop was seriously affected by unfavourable meteorological conditions and by the attack of caterpillars. In Anguilla, about 1,000 acres were planted, and the crop exceeded that of any previous year. The introduction of cotton into this island has given rise to a flourishing and prosperous industry, which has proved of great benefit to the inhabitants.

In St. Vincent the cotton crop was injured by the prevalence of continuous rain during the ripening period. Such weather not only reduces the size of the crop but also tends to lower its value by increasing the proportion of "wasty" cotton. The *Report on the Agric. Dept., St. Vincent*, 1912–13, states that the production amounted to 428,032 lb. of Sea Island cotton and 58,737 lb. of the Marie Galante variety. Sakellaridis cotton has been found to give excellent results in the Southern Grenadines, but in St. Vincent it has proved very susceptible to angular leaf-spot disease. Selection experiments have been carried out with the object of obtaining plants resistant to angular leaf-spot disease, anthracnose, and West Indian leaf mildew.

According to the *Report on the Botanic Station and Experiment Plots, Montserrat*, 1912–13, the area under cotton in Montserrat in that year was 2,063 acres, and the exports amounted to 290,390 lb., of value £18,478. Although it has generally been considered that June and July are the best months for sowing, it has now been found that with earlier planting the probability of obtaining a good second crop is increased. Experimental work has been continued and has yielded results of direct benefit to growers. Sakel-

laridis cotton grows well in the island, but is not recommended for cultivation on a large scale, as, owing to the readiness with which the lint falls from the bolls, a number of pickings are required. Abassi and Mitafifi also give good results. Attempts are being made to obtain a hybrid of the St. Eustatius native and Sea Island strains with a view to the production of a plant having the sturdy habit of the indigenous form and bearing lint of the Sea Island type.

Australia.—It is well known that large areas in Queensland and New South Wales are eminently adapted for cotton growing. The *Reports of the Dominions Royal Commission* [Cd. 7172, 7173, and 7210] record the evidence taken and the report issued with reference to this subject. It was stated by some of the witnesses that the Australian workers have an objection to the industry on account of the labour of picking, which they regard as mean and petty, and that there is not sufficient woman and child labour available to do the work. Moreover, it was suggested that the heavy cost of picking, due to the high price of labour, would render it impossible for Australia to compete with countries in which black labour can be obtained at low rates. These difficulties, however, are not regarded as insurmountable. A generous offer of co-operation towards the establishment of a cotton industry was received by the Commissioners from the British Cotton Growing Association, who urged that an agriculturist with special experience of cotton growing should be engaged for three years, and attached to one of the local agricultural departments. The Association promised to assist by a monetary grant, by provision of seed for experiments, by undertaking to superintend the sale of cotton and to guarantee a minimum price of 6½*d.* per lb., and by various other means. It was stipulated that the offer should not apply to cotton grown from perennial varieties or from ratooned plants. Both the Commonwealth and Queensland Governments have expressed themselves in agreement with the British Cotton Growing Association on all matters of principle, and it is hoped that a successful cotton growing industry will shortly be established on a permanent basis.

German Colonies.—A report on the progress of cotton growing in the German Colonies during 1912–13 (*Verhandlungen der Baumwollbau-Kommission des Kolonial-Wirtschaftlichen Komitees*, 1913, No. 1) states that cotton is at present Germany's most important Colonial product, and that in spite of numerous difficulties the industry has steadily grown from year to year. In German East Africa, about 22,000 hectares (54,400 acres) were devoted to the crop in 1912–13, of which 6,400 hectares (15,800 acres) were cultivated on the plantation system and the remainder planted by the natives. The chief centres of the industry

are the districts of Lindi in the South and Mwansa on Lake Victoria. In Togo, the expansion of cotton growing is limited to Central and Southern Togo owing to the unfavourable climatic conditions of the interior of the Colony. The production in German East Africa and Togo together amounted in 1912 to 9,730 bales of 250 kilos. (550 lb.). The estimated yield for the cotton season of 1913–14 is about 12,000 bales from German East Africa and 2,000 bales from Togo. In Kamerun, the work at the Pittoa Experiment Station near Garua has progressed so well that the cultivation can now be undertaken at Adamawa on a large scale. There are still difficulties, however, with regard to markets and transport. In order to introduce the cotton to the German spinning industry, the Colonial Economic Committee has set aside an amount not exceeding M 10,000 for the purchase of cotton produced and ginned in Adamawa.

Morocco.—It is reported in *Bulletin* No. 59, *Association Cotonnière Coloniale* (1913) that a study of the conditions in French Morocco has shown that cotton will grow in the plains of Gharb, in the Chawa, and better still in the Marakesh region, but that the cultivation can only be carried on remuneratively with the aid of irrigation. The necessary irrigation could however be easily organised. Special advantages for cotton growing offered by Morocco are that suitable land can be obtained very cheaply, and that, owing to its proximity to Europe, the cost of transport would be low.

Hawaii.—According to the *Report for* 1912–13 *on the Trade and Commerce of the Territory of Hawaii* (*Dipl. and Cons. Repts. No.* 5,253, *Annual Series* [Cd. 7048–70]), the area devoted to cotton in 1912–13 amounted to 300 acres, and yielded a crop of 250 bales of 500 lb. each. Serious damage has been caused by the pink boll-worm, and the export of cotton seed and husks has been prohibited in order to prevent the dissemination of the pest.

Brazil.—Cotton growing has made great progress recently in Brazil. It is stated in the *Journ. d'Agric. Trop.* (1913, **13**, 376) that the exports increased from 3,565 metric tons in 1908 to 16,774 metric tons in 1912. A remarkable advance took place in the early part of 1913, the exports during the first eight months of that year amounting to 21,564 metric tons as compared with 8,419 tons in the corresponding period of 1912. The exports, however, probably do not represent more than about one-fourth of the total production, which was estimated in 1912 as between 60,000 and 65,000 tons.

Tobacco

The *Rep. Dep. Agric., Union of South Africa,* 1912–13, pp. 195, 199, 204, 209, 216, records the results of variety,

curing, and seed selection trials at the various experiment stations and private farms. At Rustenberg, Transvaal, it has again been found that in growing "yellow leaf" the best results are obtained on a turf soil. The flue curing varieties "Yellow Prior," and "Boyd 1269," yielded 1,535 lb. and 1,448 lb. per acre respectively, and the air-curing varieties "Burley × Swazie" and "Swazie × Burley" yielded 1,464 lb., and 1,440 lb. per acre respectively. These two hybrids show great promise of becoming useful varieties when properly fixed; the leaf is broader and finer than the leaf of "Swazie," but not so large as the leaf of "Burley." Of the dark varieties tried the best yields were recorded for "Canter × Boyd" and "Boyd 1265," namely 1,318 lb. and 1,063 lb. per acre respectively, grown on sandy loam. A curing trial by the open fire method gave leaf of satisfactory dark to cherry red colour, but lacking in body and texture. For tobacco grown on a heavily manured soil, it is stated that this method of curing could be satisfactorily carried out in the Transvaal. There is, however, only a limited demand for this class of tobacco in South Africa, but when exported it would probably realise better prices than ordinary air-cured leaf.

In Western Cape Province, variety and manuring experiments with Turkish tobacco were carried out at thirty farms.

From the results obtained at the Barberton Experiment Station, "Sumatra (Sc)" and "Sumatra 1258" are recommended for the production of cigar-wrapper tobacco. Of the light air-curing varieties "Sterling" gave the best results, "Clardy" and "Yellow Prior" also proving satisfactory. "Macsvale" and "Clarksville N" gave the best results as heavy varieties for snuff. Two Levantine varieties, "Samsoum" and "Isketche," proved unsatisfactory at this station, yielding a coarse, dark tobacco.

For protecting seedlings, cheese cloth, placed about 6 in. above the soil, gave better results than long grass, chaff, or fresh stable manure spread over the surface, the young plants making better growth. With long grass and chaff, it was necessary to raise the covering immediately the seed had germinated, whilst manure produced an abundance of weeds. A detailed account of the cost of producing "Sumatra" and "Sterling" crops is given.

Drugs

Belladonna.—The *Ann. Rept. Kumaun* (India) *Govt. Gardens for the years* 1909–13 contain records of experiments in the cultivation of *Atropa Belladonna* from imported seed. The plants were grown at the Kutchery Garden, Naini Tal, and the yield per acre and alkaloidal content of the roots determined. Plants of one, two, and three years' growth

were examined in this way. The one-year-old plants yielded 3,570 lb. of roots per acre, containing 0·4 per cent. of alkaloid; the two-year-old plants yielded 3,545 lb. of roots per acre, containing 0·45 per cent. of alkaloid; whilst the three-year-old plants gave 2,900 lb. per acre of roots, with an alkaloidal content of 0·44 per cent. At Naini Tal the plants were found to be thoroughly established in the third year. As belladonna root imported from Europe contains from 0·2 to 0·6 per cent. of alkaloids, the samples examined are considered suitable for use in Indian medical store departments. The plant is easily grown, and is, so far, immune from insect attacks. It is believed that in better soil, such as is obtainable in the Ramgarh neighbourhood, heavier yields of root, richer in alkaloid, should be obtained. Further experiments are being made to determine whether the drug can be grown at a profit. For this purpose additional areas have been sown with seed from acclimatised plants.

FORESTRY AND FOREST PRODUCTS

The Protection of the Indigenous Flora and Fauna of Tropical Africa.—The measures taken by the countries concerned, for the protection of the indigenous flora and fauna of tropical Africa, form the basis of a paper prepared by Baron F. Fallon and read before the International Colonial Congress at Ghent in August 1913, a report of which is reprinted in *L'Agronomie Trop.* (1914, **6**, No. 1, pt. ii., p. 1). The author reviews in turn the efforts made in the various British, German, French, Portuguese, Italian, and Belgian colonies, for the protection and conservation of plant and animal life. In most British colonies great attention is paid to the regulation of felling, trees less than a certain diameter being saved. In some colonies the cutting of scarce species is prohibited, whilst in others Government forest reserves have been created. The regulations and measures against forest fires are rigorously enforced.

In all the British colonies regulations have been drawn up in accordance with the Convention for the Protection of the African Fauna, London, 1900, and these are strictly observed.

Forest Regulations of Madagascar.—The regulations, eighty-seven in number, drawn up by the French Government for the working of the Madagascar forests are enumerated in *L'Agronomie Colon.* (1913–14, **1**, Nos. 4 and 5, pp. 118, 152). They specify the conditions under which the forests may be exploited, and deal not only with the more important forest products, such as timber and fibres, but also govern the collection of such products as gums, resins, rubber, gutta, and bamboos.

Forestry in Korea.—The annexation of Korea by the Japanese in 1910 marked the institution, in the peninsula of Chosen, of a series of important administrative measures, not the least important being the proper control of the forests, which cover 73 per cent. of the total area of the peninsula.

Indiscriminate felling in the past has resulted in a scarcity of timber for building purposes and firewood, and the general deforestation has caused great injury to agriculture. The need for proper control of the forests had become so urgent that soon after the establishment of the Japanese protectorate, the late Korean Government commenced to encourage afforestation, and in 1907 began to establish model plantations and nurseries in different localities. Since 1910 this work has been extended and the report on forest work carried out in 1911–12, given in the *Annual Report on Reforms and Progress in Chosen (Korea) for* 1911–12, p. 175, records the inauguration of further improvements.

In July 1911, new forestry regulations were issued by the Governor-General. They aim not only at the continuance of the Government undertakings in afforestation, but also at stimulating the people themselves to undertake afforestation, and towards this end 4,820,000 seedlings and quantities of seed were distributed free during 1911. The investigation and survey of the forest boundaries have been commenced, while the botanical survey, though not yet completed, proves that about 300 species of trees exist in the peninsula.

The Beeches, Birches, and Maples of the United States.—The uses of the various species of *Fagus*, *Betula*, and *Acer* indigenous to the United States, where they are frequently known as "the hardwoods," are dealt with in *Bulletin* No. 12, 1913, *U.S. Dept. Agric.* The three genera, including eighteen commercial species, form a group of trees closely related in the technical properties of their timbers. They grow usually in the same regions and are frequently lumbered and milled as a single wood, though the resulting timber is piled and sold separately. The woods of all the species have several points of similarity, such as hardness, strength, and capability of fine polish, and, in the main, their uses are similar, the chief being for furniture, flooring and interior work, for agricultural implements and vehicles, musical instruments, and for domestic articles.

Prosopis juliflora.—Reference has been made previously in this Bulletin (1913, **11**, 355), to the value of *P. juliflora* as a pioneer tree and sand-binder in the dry soils and arid districts of India. In the *Indian Forester* (1913, **39**, 320), a further account of its behaviour in the Punjab is given. Natural seedlings of this tree are said to be almost always

found on dry unirrigated land wherever large specimens occur, whilst seedlings of indigenous trees in such situations are usually absent. In resistance to drought *P. juliflora* has proved to be without an equal in the Punjab, and as it produces seeds in abundance it seems probable that it will become a common tree in all the drier districts in course of time. Its leaves are not readily eaten by cattle, and it appears to have no natural enemies in India, but a large proportion of the seed imported from America, where the tree is native, is said to be usually attacked by weevils.

Teak Cultivation in Java.—The teak forests of Java, which are estimated to occupy an area of from 600,000 to 650,000 hectares (1 hectare = 2·47 acres) are the property of the State. This increases year by year as a larger area is planted annually than is exploited. It is estimated that some 125,000 hectares have been planted during the last twenty-five years. The methods of culture adopted, as described in the *Journ. d'Agric. trop.* (1913, **13**, 353), are as follows: Soils of at least average richness are chosen for teak, as on poor or marshy land growth is very slow; wet soils can, however, be utilised if drained. A rainfall of at least 24 in. a year is essential, and an altitude not above 300 ft.

The trees are raised from seeds planted about 3 ft. apart, in lines 9 ft. apart, at the beginning of the rainy season. During the first year natives are allowed to cultivate rice and afterwards ground nuts between the lines. The growth is very rapid at first, and by the end of the first year the seedlings have become small trees. Little care is required to maintain the plantations beyond keeping out "alang-alang" (*Imperata arundinacea*), a grass which checks the growth of teak considerably. It has been found as a result of recent trials that the best method of checking the growth of alang-alang is to sow *Leucaena glauca* between the lines of teak. This is a leguminous plant, and is used in Java as a shade tree for coffee. Not only does it smother the grass, but it prevents the surface soil being washed away during heavy rains, and enriches the soil by adding humus and nitrogen. As soon as the teak trees have become large enough to form a canopy the Leucaena disappears. Teak forests formed in this way consist of trees with slender stems and few branches, standing very close together. Thinnings are necessary about every five years, and these afford sufficient wood to cover the cost of exploitation. For about three months during each year the teak trees lose their leaves, and as this occurs during the dry season there is then danger of fires; it is at this period also that the alang-alang makes advances, as there is then an absence of shade which is favourable to its growth.

The artificial teak forests of Java are at present young,

and it is not yet possible to say at what age the trees will attain a diameter of about 2 ft., which is the size fixed for exploitation; but in all probability this will be between eighty and a hundred years.

In the case of natural forests, which are the only ones at present exploited, the trees are ringed two years before being felled, and allowed to stand in order to acquire those qualities which give teak its value as timber. The ringing of the bark is done close to the soil, and also the cutting of the wood, to minimise loss of timber. The bulk of the teak produced in Java is used locally.

ECONOMIC MINERALS

Building Stones.—The Mines Branch of the Canadian Department of Mines has issued vol. i., by W. A. Parks, of a *Report on the Building and Ornamental Stones of Canada* (Ottawa: Government Printing Bureau, No. 100, 1912). This volume consists of two parts. Part I. is a general introduction to the subject, and deals with the chemical, physical, and geological features of building stones, together with the methods of quarrying, testing, and preparing stone for the market. Part II. gives a systematic description of the building and ornamental stones occurring in that part of Ontario lying south of the Ottawa and French rivers. It is the intention of the Department of Mines to issue a series of these volumes on the Building and Ornamental Stones of Canada. Each report is to deal with a certain section of the country, and the reports are to appear yearly, until practically all the stones now being quarried in the Dominion have been described. The first volume is richly illustrated.

Diamonds.—In the *Trans. Geol. Soc. South Africa* (1913, **16**, 39), R. B. Young reports the discovery, by A. C. Lurie, of a diamond crystal in the black sands from the mortar boxes of the Modderfontein Branch Gold Mine. Diamond occurrences have been reported on previous occasions from the Rand banket. In this case the stone weighed about three-quarters of a carat, and was of a greenish colour. It had the form of the hexakis-octahedron with curved and slightly worn faces. All the stones hitherto obtained from the banket have been greenish in colour, and this is regarded as a proof that the occurrences are genuine. It is regarded as certain that the diamonds in the banket were deposited with the pebbles during sedimentation. The occurrence is of interest as proving that there exists a source of diamonds in the pre-Witwatersand rocks from which the banket was derived.

Gold.—The gold production of the Federated Malay States for 1913, as reported to the Secretary of State for the Colonies, is as follows:

	Oz. (troy).	Value at £3 17s. 6d. per oz.
Gold exported from the Federated Malay States	13,133	£50,891
Gold reported to have been bought by buyers in Perak	1,842	7,138
Total	14,975	£58,029

This shows an increase of 554 oz. as compared with 1912, in which year the total production was 14,421 oz., valued at £55,881.

Iron Ore.—In *Economic Geology* (1914, **9**, 101) there is an article on the "itabirite" iron ores of Minas Geraes, Brazil, by E. C. Harder, a geologist who has had a considerable amount of experience among these deposits. Itabirite is the name given to a bedded siliceous iron-ore formation occurring in association with quartzites and schists. The itabirite formation varies in thickness from less than 15 metres to over 1,500 metres. Itabirite rarely contains less than 30 per cent. of metallic iron, and grades upwards through less siliceous material to richer ores containing not less than 50 per cent. of metallic iron. In addition to these massive deposits of more or less siliceous hæmatite, there is much ore (the so-called "canga") with a limonitic cement; this occurs at the surface, and has been formed by the action of weathering agencies on the itabirite. Soft powdery deposits of iron ore also occur, but though these have a high percentage of iron, they are considered undesirable because of their consistency. Occurring in the itabirite there are beds of hard massive iron ore of high grade, containing from 69 to 70 per cent. of metallic iron, and from 0·003 to 0·020 per cent. of phosphorus. This high-grade ore consists as a rule of finely specular hæmatite, but is occasionally of a coarse texture with an admixture of magnetite. It rarely contains more than 1 per cent. of silica, and its percentage of iron is remarkably constant. It occurs in lenses and beds varying up to more than a kilometre in length, and more than 150 metres in thickness. This is the only type of ore that is being considered at present in connection with the development of the Brazilian iron industry. As regards mode of origin, it is concluded that the itabirite deposits were formed as sedimentary rocks, and that they were subsequently altered, not by the action of weathering agencies, as some have supposed, but by deep-seated metamorphism. As evidence in support of the "sedimentary" view, it is mentioned that (1) the formation consists of a conformably bedded series; (2) the itabirite is interbedded with limestone; and (3) a difference is clearly discernible between beds that have been affected by weathering processes and those not so affected. This question of the origin of the itabirite ores is

one of considerable importance, since, if they were formed as sedimentary beds, they are likely to extend to a considerable depth; whereas, if they were formed by the concentrating effect of surface agencies, they are likely to be comparatively shallow in depth.

In *Bulletin* No. 64, 1913, *United States Bureau of Mines*, J. T. Singewald gives an account of the composition and economic value of the titaniferous iron ores in the United States. He deals with the results of an investigation into the economic possibilities of the larger deposits, and the applicability of processes of concentration in the utilisation of these ores. He gives a detailed account of the physical structure and chemical composition of the ores, and pays special attention to the possibility of utilising titaniferous iron ores at a profit with present methods and under existing conditions. The results of the investigation are chiefly negative, and on the whole disappointing. Some of the titaniferous iron-ore deposits are neither as large nor as good in quality as they were reported to be. It has been found that though a large part of the titanium in the ores is in the form of ilmenite, much of this is so intimately associated with the magnetite that separation by the magnetic method is, as a rule, impracticable. Only in a few cases are the ilmenitic portions of the ore sufficiently coarse to enable satisfactory results by magnetic separation to be obtained. In most cases, therefore, the problem presented is that of finding a suitable smelting process for the ore. In this direction the use of the electric furnace for the production of iron-titanium alloys seems to be the most promising line of development, as iron-masters are disinclined to adapt blast-furnace usage to the smelting of these titaniferous iron ores. The Bureau of Mines has undertaken further experiments on the possibility of adopting more efficient smelting methods, and promises to give the results of these experiments in future reports.

The Mines Branch of the Department of Mines, Canada, has published an account of the Austin-Brook iron-ore deposits, New Brunswick, by E. Lindeman (Ottawa: Government Printing Bureau, 1913, No. 105). These deposits are situated in Gloucester county, about 23 miles south-west of the town of Bathurst. The rocks of the district are chiefly foliated quartz-porphyry, associated with chlorite and sericite schists. The porphyry is traversed by gabbros and quartz veins, and appears to be intrusive in a slate formation which is probably of Ordovician age.

The ore bodies occur as elongated lenses in the quartz porphyry, and like the latter, are foliated. The ore is a fine-grained siliceous magnetite with a considerable amount of hæmatite, and it often shows bands of jasper. The metallic iron percentage of the ore varies from 35 to 59, the average

being about 45. The amount of sulphur is from 0·03 to 0·1 per cent. and phosphorus 0·8 per cent. Where the ore body is in contact with the country rock there are layers of iron pyrites, and ore taken from this position is liable to be high in sulphur.

The ore in its natural state is too siliceous to be marketable and requires to be concentrated. At the time of writing the report, a jigging process had been adopted, and a mill had been erected to treat 70 tons of crude ore per hour. A railway has been laid to the deposit, and an ore dock for transhipment has been built at Newcastle. The dock has a storage capacity of 13,000 tons, and a loading capacity of 3,000 tons per hour. The distance by railway from the mine to Newcastle is 57 miles. During 1910 and 1911 the shipments were 5,336 tons and 31,120 tons respectively.

Nickel Ore.—The Mines Branch of the Canadian Department of Mines has issued a well-illustrated monograph on "The Nickel Industry, with special reference to the Sudbury region, Ontario," by A. P. Coleman (Ottawa: Government Printing Bureau, 1913). The monograph includes a general geological map and special maps of the more important mines, and incorporates the advances made in a knowledge of the region due to work in the field extending over three summers. An account is given of the geology of the Sudbury region and of the mineral composition of the ores. All the known nickel ore deposits in Ontario are described in detail, and an account is given of the methods of mining and smelting the ores. The nickel deposits of other countries, including those of the United States, Cuba, Europe, New Caledonia, and Cape Province (Union of South Africa) are also dealt with.

Petroleum.—In a pamphlet dealing with the prospect of mineral oil being found in payable quantities in the Federated Malay States and other parts of the Malay Peninsula (Kuala Lumpur: F.M.S. Government Printing Office, 1913), J. B. Scrivenor gives a brief account of the conditions of occurrence of petroleum, and deals with the geology of the Malay Peninsula in relation to oil-occurrence. He infers that the conditions to be sought for in prospecting for oil are as follows:

1. Porous rocks capable of holding oil.
2. Beds rich in fossils, especially plant remains, that might form oil.
3. A structural arrangement of the rocks, such as an anticline, that favours storage of oil under pressure in porous rock underneath an impervious rock.
4. A porous rock outcropping on the surface through which oil is being floated upwards by rising water, giving surface evidence of oil.

In answering the question whether these conditions obtain in the Malay Peninsula, he states that the greater part of the country is composed of rocks, older than the Mesozoic granite, which have lost whatever porosity they once possessed, and are therefore incapable of holding oil. Of the deposits younger than the Mesozoic granite, the coast deposits are, he believes, too young to furnish any large quantity of oil. This leaves only the Tertiary rocks, of which only two outcrops are known, and it is to these that the attention of the prospector is directed. He concludes that, on the whole, the prospects of finding payable quantities of oil in the Peninsula are not encouraging.

NOTICES OF RECENT LITERATURE

THROUGH JUBALAND TO THE LORIAN SWAMP. By I. N. Dracopoli, F.R.G.S., with 44 illustrations and 2 maps. Pp. 318, Demy 8vo. (London: Seeley, Service & Co., 1914.) Price 16*s.* net; post free, United Kingdom 16*s.* 5*d.*, abroad 16*s.* 9*d.*

In the vast unexplored and uninviting lands between the Tana and the Juba Rivers, in British East Africa, Mr. Dracopoli has carried out, with conspicuous success, a journey of exploration between Kismayu, on the coast, and the Lorian Swamp, and has brought back an excellent map from plane table and prismatic compass traverses along his line of route. Special attention was given to the geography, the natives, and the natural history of Jubaland. In the handsome volume which records the results of this journey of exploration a very full account of southern Jubaland and of the obstacles that were successfully overcome in penetrating this difficult, and in many parts previously unknown, country is given. The hydrography of the inland drainage area, between the Juba and Tana Rivers, is very complex; there are no permanent streams and but few water-holes. Mr. Dracopoli's journey was an essential step to settlement in the country. His investigation of the Uaso Nyiro, connecting with the Lorian Swamp, and of the unknown country to the east, as far as Afmadu, is a valuable contribution to geography.

THE SETTLER AND SOUTH AFRICA. By William Macdonald, D.Sc. Pp. 159, Pott 4to. (London: Union-Castle Line, 1913.) Price 6*d.*; post free United Kingdom and abroad 9*d.*

This excellent little book is to be warmly recommended to those proposing to farm in South Africa—a term which may be held to include Swaziland and Rhodesia. People in this country who regard "South Africa" as synonymous with mineral wealth, and little else, would do well to consider the numerous and varied agricultural industries

described by Dr. Macdonald, and to reflect upon the potentialities involved. In the opinion of the author the Land Settlement Act of 1912 is destined to have a profound influence upon the future of South Africa. Under this Act, the Minister of Lands possesses wide powers over funds voted by the Union Parliament for "closer settlement," upon which the agricultural development of the country in great measure depends. The conditions imposed for a Government holding are not onerous, but they assume a certain amount of capital in the possession of the farmer, for South Africa is not the country for a settler virtually destitute of means. The needs of the farmer are now well served by the Government, which, in addition to the Land Settlement Act already referred to, supports a highly organised Department of Agriculture and a Land Bank. On these matters and on those relating to the crops and industries themselves—maize, fruit, wattle, tea, wine, wool, livestock, dairying, and ostrich farming, to mention the more important—the intending settler will find concise, scientific information that should be of great value to him in directing his energies upon right lines. The book is well printed, admirably illustrated, and issued at a negligible price.

Beyond the Pir Panjab. Life and Missionary Enterprise in Kashmir. By Ernest F. Neve, M.D., F.R.C.S. (Edin.) Pp. viii + 178, Demy 8vo. (London: Church Missionary Society, 1914.) Price 2*s.* 6*d.*; post free, United Kingdom 2*s.* 10*d.*, abroad 3*s.*

Dr. Neve gives in this book a very interesting account, based on an experience covering a quarter of a century, of the beautiful vale of Kashmir and its primitive inhabitants, together with a record of missionary enterprise, educational and hospital work. He also has something to say on Kashmiri Tibet, and provides a valuable chapter on the Upper Indus Valley; he concludes with a general survey of Kashmir as a sphere for medical mission work, the extent and value of which have an important bearing on the development of the country. The illustrations are excellent.

A View of the Art of Colonization, in letters between a Statesman and a Colonist. By Edward Gibbon Wakefield. With an introduction by James Collier. Pp. xxiv + 510, Extra Crown 8vo. (Oxford: Clarendon Press, 1914.) Price 5*s.* net; post free, United Kingdom 5*s.* 4*d.*, abroad 5*s.* 8*d.*

A reprint of Wakefield's famous treatise on the whole *Art of Colonization* (1849), with an introduction by Mr. James Collier, should go far to stimulate an interest in the fundamental problems of national colonisation and Imperial development, which too often are made subservient to the immediate practical needs of migration and commercial

exploitation. Wakefield in his day, as is well known, was a leading Colonial Reformer and a thorn in the side of constituted authority: his fiery crusade against "Mr. Mother-country" rule kept him in constant conflict. Thrown into the form of an interchange of letters between "the Colonist"—Wakefield himself—and "the Statesman," whose identity is still unknown, the views of the author are set forth with a freshness and verve that compensate for their imperfect manner of presentation. His principal and successful reform—the sale of waste lands in the Colonies at a "sufficient price"—is dealt with in elaborate detail; otherwise his views in this volume are somewhat fragmentary and inconclusive, and some of course are inapplicable at the present day. But the principles and theories that underlie and support his system of colonisation remain of fundamental value.

CANADIAN ADDRESSES. By the Hon. George E. Foster. Edited by Arnold Winterbotham. Pp. xxi + 324, Crown 8vo. (London: Herbert Jenkins, Ltd., 1914.) Price 5*s.* net.; post free, United Kingdom 5*s.* 4*d.*, abroad 5*s.* 5*d.*

In these addresses the views of a Canadian statesman (Minister of Trade and Commerce) on leading problems of the British Empire are set forth with eloquence and insight, and with a breadth of treatment that arrests and holds the attention of the reader. Mr. Foster has the uncommon gifts of being able to appreciate, and to state with fairness and precision, not only the splendid heritage and opportunities of the Dominions but also their prime indebtedness to the Mother country and their obligations as integral parts of a united Empire. This relationship has seldom been discussed with greater skill and individual detachment: and the author's tribute to the responsibilities and claims of the parent State will recommend Mr. Foster's Addresses to a wide audience. "Our greatest enemies," says Mr. Foster in his introduction, "are drift and *laissez faire.* Let us enthrone organisation—Empire organisation and development; broad-based and effective. Let us rekindle the ancient fires of patriotic service, reincarnate the ancient virtues of courage and sacrifice, and begin at once the great crusade for the regeneration and firm establishment of an Imperial Britain." Autonomist as regards the Dominions, he is frankly an Imperialist in his outlook on the Empire.

MAIZE: its History, Cultivation, Handling and Uses; with special reference to South Africa. By Joseph Burtt-Davy, F.L.S., F.R.G.S. Pp. xl + 831, Med. 8vo. (London: Longmans, Green & Co., 1914.) Price 25*s.* net; post free, United Kingdom 25*s.* 6*d.*, abroad 26*s.* 4*d.*

The author is to be congratulated on this comprehensive work, which must for long stand *facile princeps* in the ex-

tensive literature of maize. The remarkable position of maize as a feeding-stuff, and the part it plays in the world's agriculture, are scarcely realised in this country. Maize is stated to be produced in greater quantity than any other cereal, the world's annual crop reaching nearly 4,000 million bushels, three-quarters of which are raised in the United States. In 1899, the American crop exceeded in value by £5,000,000 all the products of the iron and steel industries of that country, and surpassed the combined value of the wheat and cotton crops. The secondary position of maize in European markets is no doubt in part due to the fact that, in spite of the enormous American production, the grain is not grown in the United States for export purposes: no less than 98 per cent. of the total crop is retained in the country, and the major part converted into beef or pork before it leaves the farm on which it was grown.

An attractive feature of maize-growing is the stability of the demand for the product, and this fact has a powerful influence in inducing agriculturists in "new" countries to rely, in varying measure, upon the crop. In this connection reference may be made to the development of the maize industry in South Africa, in which the part played by the author, as Government Agrostologist and Botanist, is well known. Maize has become the staple cash crop of the South African farmer, and Mr. Burtt-Davy regards the country as unrivalled, in natural conditions, as a maize-growing area, stating that the climatic circumstances of a large part of the Orange Free State, the Transvaal, Natal, Rhodesia, Basutoland, Swaziland, and the Transkei, are all that could be desired for the crop.

The economic and agricultural conditions under which the American farmer raises his crop should be borne in mind by maize-growers in all parts of the world. In the corn belt of the United States, maize is raised entirely by white labour earning £5 a month and board, yet the crop pays because it can be handled almost entirely by machinery; because the soil is in good condition and the crop well cultivated; and because the farmer realises the value of good seed: moreover, the great bulk of the crop is raised on small or moderate-sized farms of from 80 to 300 acres.

Space does not permit of adequate reference to the large amount of information brought together in this volume. Among the most important sections are those dealing with the improvement of the crop by selection and breeding, and the cognate subjects of "varieties and breeds," and "judging and selection." The chapter on the "inheritance of characters and improvement by breeding" is admirable, and of especial significance for South African farmers. It is pointed out that if South Africa is in fact to become the "maize granary of Europe," a greater

production is a necessity, since, unless the present output is increased, there is some risk of a loss of the market she has already gained for lack of a constant, dependable supply. A larger production may be secured by an extension of the area under the crop, a more intensive cultivation, and the increase of the yield per acre by scientific plant-breeding. There would appear to be ample room for improvement in the South African yield, which is reported to average no more than 4 to 5 muids ($14\frac{1}{4}$ to 18 bushels) per acre; but it has now been shown that, without undue expense, yields of 10 to 12 muids ($35\frac{1}{2}$ to $42\frac{1}{2}$ bushels) can be obtained over hundreds of acres. The chapters on the culture of the crop and the related matters of diseases, harvesting, and storage, are thoroughly practical, and, while primarily concerned with South African experience, should be of the greatest service to all maize-farmers. The crop is dealt with entirely from the modern standpoint, full reference being made to the employment of labour-saving machinery, several types of which are illustrated. Much important information is contained in the chapter on "Commerce in Maize Grain," in which will be found an account of the Government system of grading and an explanatory list of the now well-known standard "classes" of South African maize. Samples of these grades are furnished regularly to trade organisations in this country, and a series is exhibited in the South African Court at the Imperial Institute.

Reference must be made to the numerous and excellent illustrations and to the exhaustive bibliography, while the complete index is a valuable feature. In the chapter on "botanical characters" an error has been overlooked in quoting the castor-oil bean as an example of an "ex-albuminous" seed.

Coconut Cultivation and Plantation Machinery. By H. L. Coghlan and J. W. Hinchley, A.R.S.M., Wh.Sc., F.C.S. Pp. x + 128, Small Crown 8vo. (London: Crosby, Lockwood & Son, 1914.) Price 3*s.* 6*d.*; post free United Kingdom and abroad 3*s.* 9*d.*

This small book covers a wide field and includes a large amount of useful information on the establishment and management of coconut plantations in Malaya; the pests and diseases of the coconut; the preparation of copra, oil, and coir fibre, and the machinery used. It also deals with other subjects closely allied to the coconut industry, such as the cultivation of Robusta coffee as a catch crop. The coconut industry of the West Indies is briefly dealt with in the concluding section.

The information is in a very condensed form, but appears to be accurate. The book is free from errors or misprints, but the description of rough methods of soil

analysis in less than two pages might be omitted with advantage; soil analysis is best left to trained chemists, and results of real value could not be obtained by the rough methods described.

ALL ABOUT COCONUTS. By R. Belfort and A. J. Hoyer. Pp. xii + 201, Demy 8vo. (London: St. Catherine Press, 1914.) Price 6*s*. net; post free, United Kingdom 6*s*. 4*d*., abroad 6*s*. 7*d*.

This book is written in a popular style, and has obviously been compiled chiefly for the purpose of affording the reader an idea of the financial and industrial possibilities of coconut planting in different countries. The information given is generally correct, though it is sometimes conveyed in language that is perhaps unduly eulogistic. For the actual planter's use detailed references to the original sources of information would have added greatly to the value of the book. References of this kind are particularly needed in such cases as those on pages 134 and 135, where different processes for the sterilisation of copra are referred to, but where no details are given.

The sections dealing with the coconut planting industry are among the best in the book, but those dealing with the preparation and utilisation of coconut-palm products, such as coir, copra, and oil, are distinctly poor. The authors should have enlisted the services of a qualified technologist to assist with this important part of their book. The book contains numerous illustrations, most of which are excellent.

THE CULTIVATION OF THE OIL PALM. By F. M. Milligan, F.R.G.S. Pp. xii + 100, Small 8vo. (London: Crosby, Lockwood & Son, 1914.) Price 2*s*. 6*d*. net; post free United Kingdom and abroad 2*s*. 9*d*.

The cultivation of the oil palm is a subject of increasing importance, about which comparatively little is known owing to the fact that so far natural regeneration of the tree has been relied on almost entirely. In these circumstances it is by no means easy to give trustworthy and complete advice on all the questions which arise in the formation of an oil-palm plantation, and this little book reflects this difficulty. It is written in a discursive style, and the information is often too vague and general to be of real value, and is sometimes misleading. A notable omission is the absence of any reference to the existence of varieties of the oil-palm, some of which are preferable to others for planting purposes if they can be grown true to seed. Nevertheless, the book contains some sound advice, and if the author would drastically revise what may perhaps be called the scientific portions of the book, and add a chapter on oil-palm machinery, it could be made into a useful treatise on the subject, and a book of this kind in English would be very valuable at the present time.

Der Baumwollbau in den Deutschen Schutzgebieten: seine Entwicklung seit dem Jahre 1910. Pp. ix + 295, Med. 8vo. (Jena: G. Fischer, 1914.)

In 1910, the German Colonial Office issued a work entitled *Die Baumwollfrage* (cf. this Bulletin, 1911, **9**, 190), which drew attention to the deficiency in the world's production of cotton and the causes thereof, and indicated the measures which were being taken by different countries to increase the supply. In the same year an arrangement was concluded between the Secretary of State for the German Colonies and the Colonial Economic Committee, in accordance with which the Government undertook to co-operate in the work of advancing cotton growing in the Colonies. Since that time much earnest and laborious work has been done, a record of which has now been published by the German Colonial Office in the volume under notice. Separate chapters are devoted to German East Africa, Kamerun, and Togo, and in each a detailed account is given of the natural conditions of the country, the measures which have been taken to develop cotton growing, and the results so far achieved. The work is well illustrated with photographs and plans of the various experiment stations, and constitutes a valuable memoir of German activity in the direction of cotton cultivation.

A Textbook of Medical Entomology. By W. S. Patton, M.B., I.M.S., and F. W. Cragg, M.D., I.M.S. Pp. xxxiii + 764, Small 4to. (London, Madras, and Calcutta: Christian Literature Society for India, 1913.) Price 21*s.*; post free United Kingdom 21*s.* 7*d.*

The need for a comprehensive book dealing with entomology in relation to disease has been long felt by medical officers in the tropics. Until recently, when journals specially devoted to this subject were founded, the results of investigations were recorded in many publications, and the authors of the present work have performed a most useful service in gathering together this scattered information and making it available to those workers who are out of reach of extensive libraries.

After a detailed account of the anatomy and physiology of the blood-sucking flies, the different families of Diptera are dealt with, special attention being paid to those insects which occur in tropical regions. The bionomics of the insects are considered in detail, and descriptions of the various genera and species of mosquitoes, house-flies, midges, etc., are provided. Subsequent chapters deal in a similar way with fleas, bugs, lice, ticks, mites, tongue-worms, and water-fleas. A most valuable feature is the description of the various methods of breeding blood-sucking insects in the laboratory for the purpose of investigating their relation to disease. A chapter is devoted

to the preparation and microscopical examination of insect tissues, and the book concludes with a general discussion of the relations between blood-sucking insects and disease.

There are eighty-nine plates of line and half-tone drawings, illustrating the structure of the insects dealt with, and references are given to the more important literature dealing with the various groups.

THE DIAMOND FIELDS OF SOUTHERN AFRICA. By P. A. Wagner. Pp. xxv + 347, Small 4to. (Johannesburg: *The Transvaal Leader*, 1914.) Price 27*s.* 6*d.* net; post free, United Kingdom 28*s.*, abroad 28*s.* 9*d.*

This book is a revised and greatly enlarged English edition of Dr. Wagner's *Die Diamantführenden Gesteine Südafrikas, Ihr Abbau und Ihre Aufbereitung*, which was published in 1909. Since that time the author has pursued his studies among the South African diamond fields, with good opportunities for making further observations and collecting. How well be has used those opportunities this book testifies.

It is divided into three parts. Part I. deals with "The Primary Occurrences," and includes an account of the geology, petrography, and mineralogy of the rock (kimberlite) in which the diamonds occur. This part also includes a discussion of the origin of the diamond, a description of the methods of mining and concentration, and an account of the economics of diamond mining. Part II. describes the alluvial deposits of the Vaal River basin, the Orange River valley, and German South-West Africa. Part III. gives an account of the diamond-mining companies in various parts of South Africa, and deals with statistics of production, etc.

The treatment of the subject is well-balanced and thoroughly up-to-date, incorporating, as it does, even the most recent work. The author himself has contributed several notable scientific papers on the subject, and has made a close study of the work done by others, as is shown not only in the comprehensive bibliography which he has given to the reader, but also in the concise way in which he has stated the views of the various authorities to whose work he refers.

One unpardonable error committed by the author is the absence of an index. An attempt has been made to compensate for this by giving a fairly full list of contents, but a good index is indispensable for reference in a book of this character, and it is to be hoped that in future editions this defect will be remedied.

The illustrations are numerous and good; they include several maps, one of the diamond fields of Griqualand West, and another showing the principal occurrences of kimberlite and alluvial diamond-bearing deposits of South Africa.

The book is clearly written, well printed, and only a few misprints have been noticed. It is readable as well as scientific, and can be recommended to any one who wishes to have a complete and trustworthy account of the South African diamond deposits and their exploitation.

La Silice et les Silicates. By H. Le Chatelier. Pp. 574, Roy. 8vo. (Paris: A. Hermann et Fils, 1914.) Price 15 francs; post free, United Kingdom 12*s.* 7*d.*, abroad 13*s.* 5*d.*

In this treatise the author has dealt with silica and silicates chiefly from a scientific, and to some extent also from a technical, point of view. The matters dealt with include a description of the different varieties of silica, the optical and other physical properties of quartz, transformations of silica at different temperatures, the properties and different varieties of glass and other silicates, ceramics, rocks, and slags.

It is scarcely wise to expect from one author that he should be able to deal adequately with all these subjects. The task is one calling for the co-operation of many specialists rather than the efforts of one worker. M. Chatelier has brought together a large amount of information, but it is to the general reader rather than to the specialist that his book will appeal.

Very little is said about the chemical constitution and analysis of silica and the silicates, and the mineralogical treatment of the subject is not only incomplete, but contains many misleading statements. Thus on p. 414 the reader is informed with reference to wollastonite that "C'est un élément constitutif des syénites à néphéline."

Again on p. 456 the term "kaolinite" is used as if it should be applied to a substance having the chemical composition represented by the formula $Al_2O_32SiO_22H_2O$, irrespective of the physical condition of the substance.

Some twenty pages devoted to rocks deal only with the origin and classification of rocks, and an account is given of the quantitative system of classification. With reference to classification it is scarcely correct to say, as M. Chatelier does, that "On divise généralement les terrains en quatre grands groups: les roches sédimentaires, les roches volcaniques, les roches filoniennes, les roches primitives cristallisées" (p. 517). Moreover, if one is to deal with rocks in a publication such as this, it would be better to give some simple and illustrated account of their nature and texture, and show how they differ from one another.

The inadequacy that characterises M. Chatelier's scientific treatment characterises also his treatment of the technical aspects of silica and the silicates. Glass is dealt with at some length, but any one requiring information on silica and the silicates in relation to the cement, ceramic,

and metallurgical industries is not likely to find the book of much use. Moreover, only the properties of the various substances concerned are dealt with at any length, no attempt being made to describe actual processes of manufacture.

The illustrations are few, and there are some fairly obvious misprints. The book is of some value as a readable compilation giving a large amount of information, and showing how important silica and the silicates are to workers in various sciences and industries; but its value as a work of reference is seriously diminished by the absence of an index.

The Mining World Index of Current Literature. Vol. IV., second half-year, 1913. By G. E. Sisley. Pp. xxviii + 190, Med. 8vo. (Chicago: The Mining World Company, 1914.) Price $1.50; post free, United Kingdom 6*s.* 7*d.*, abroad 6*s.* 10*d.*

This is the fourth volume of the Mining World Index of Current Literature. Like previous volumes, it attempts to cover the world's literature on mining, metallurgy, and kindred subjects. It claims to classify "all articles appearing in periodical magazines published in America, Europe, Africa, and Australia on mining, mining engineering, metallurgy, mining geology, mineralogy, etc.; also the valuable publications of the world's mineral industries, institutes, and affiliated engineering and technical societies, as well as publications of the federal and state geological surveys and mining bureaus at home and abroad." On looking through its list of publications indexed, however, one misses some that might well be included. Of these the *Mineralogical Magazine* and the *Journal of the Institute of Metals*, both of London, should be mentioned; also the publications issued by the Government Geologist of the Federated Malay States, and the *Bulletins* of the Geological Survey of Southern Rhodesia.

One needs only to glance through the pages of this index to see how very useful it is, and every step in the direction of greater completeness will be welcomed by those who use it.

BOOKS RECEIVED

The Oxford Survey of the British Empire. Edited by A. J. Herbertson, M.A., Ph.D., and O. J. R. Howarth, M.A. 6 vols. Vol. I.: The British Isles and Mediterranean Possessions. Pp. xii + 596. Vol. II.: Asia. Pp. x + 505. Vol. III.: Africa. Pp. xvi + 547. Vol. IV.: America. Pp. x + 511. Vol. V.: Australasia. Pp. xii + 584. Vol. VI.: General Survey. Pp. viii + 386. (Oxford: Clarendon Press.) Price, £3 10*s.* net; or, separately, 14*s.* net per volume.

THE WILDS OF MAORILAND. By J. M. Bell, M.A., Ph.D. Pp. xiii + 257. (London: Macmillan & Co., Ltd.) Price 15*s.*

NEW ZEALAND: Its History, Commerce and Industrial Resources. Compiled by Somerset Playne, F.R.G.S., assisted by J. W. Bond and H. H. F. Stockley, F.R.G.S. Edited by F. Holderness Gale. Pp. 699. (London: The Foreign and Colonial Compiling and Publishing Co.) Price 25*s.* net.

LA GÉOGRAPHIE DE TERRE-NEUVE. By Robert Perret. Pp. vi + 372. (Paris: E. Guilmoto.) Price 10 francs.

INDUSTRIAL AND COMMERCIAL GEOGRAPHY. By J. Russell Smith. Pp. xi + 914. (London: Constable & Co., Ltd.; New York: Henry Holt & Co.) Price 15*s.* net.

CULTURE ET EXPLOITATION DU CAOUTCHOUC AU BRÉSIL. By O. Labroy and V. Cayla. Pp. 235. (Paris: Société Générale d'Impression.)

DATE GROWING IN THE OLD WORLD AND THE NEW. By Paul B. Popenoe. Pp. 316. (Altadena, California: West India Gardens.) Price $2 net.

THE TIMBERS OF BRITISH GUIANA: A Report upon the Collection made by the Hon. A. G. Bell, M.Inst.C.E. By Herbert Stone and W. G. Freeman. Pp. xi. + 110. (London: The Crown Agents for the Colonies.) Price 5*s.* net.

DIE WICHTIGSTEN KRANKHEITEN UND SCHÄDLINGE DER TROPISCHEN KULTURPFLANZEN UND IHRE BEKÄMPFUNG. By Fr. Zacher. Band I. Pp. viii + 152. (Hamburg: Fr. W. Thaden.) Price 4 marks.

IGNEOUS ROCKS AND THEIR ORIGIN. By R. A. Daly. Pp. xxii + 563. (London: Hill Publishing Co.) Price 17*s.* net.

MANUAL OF PETROGRAPHIC METHODS. By A. Johannsen, Ph.D. Pp. xxviii + 649. (London: Hill Publishing Co.) Price 25*s.* net.

DAS AUFSUCHEN UND DIE UNTERSUCHUNG VON LAGERSTÄTTEN NUTZBARER MINERALIEN IN DEN TROPEN. By O. Mann. Pp. iv + 92. (Hamburg: Fr. W. Thaden.) Price 2.80 marks.

The Fixation of Atmospheric Nitrogen. By J. Knox, D.Sc. Pp. vii + 112. (London: Gurney & Jackson.) Price 2*s*. net.

The American Fertilizer Handbook, 1914. Pp. 470. (Philadelphia: Ware Bros.) Price $1.

Directory of Paper Makers of the United Kingdom for 1914. Pp. 235. (London: Marchant Singer & Co.) Price 1*s*. net.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial, Indian and other Governments concerned.

ECONOMIC PRODUCTS FROM THE ZANZIBAR PROTECTORATE

In a later section of this Bulletin (p. 407) will be found an article by Mr. F. C. McClellan, Director of Agriculture in Zanzibar, dealing with the agricultural resources of that Protectorate. Specimens of most of the products referred to therein have been examined at the Imperial Institute, and an account of the results of examination of those received in recent years is given in the succeeding pages. The specimens of leguminous seeds, millets and oil seeds dealt with represent the ordinary produce as grown by the natives. Previous articles dealing with Zanzibar products will be found in the following numbers of this Bulletin: mangrove barks and leather (1904, **2**, 163); *Telfairia pedata* seeds (1912, **10**, 223); cloves (1912, **10**, 572); clove-leaf oil (1913, **11**, 438.)

Cloves

The seven samples which are the subject of this report were received in December 1913. They consisted of cloves, clove stems, and clove fruits ("mother of cloves"), and it was desired to ascertain the percentage of oil which they contained and their market value.

No. 1. "*Cloves from tree* 8 *to* 9 *years old. Loss in weight by drying* 67·3 *per cent.*"—These cloves were of deep brown colour and had an average length of $\frac{5}{8}$ in.

No. 2. "*Stems from No.* 1."—These consisted of the

stalks of the inflorescence from which the buds (cloves) had been removed.

No. 3. "*Cloves picked just before the buds turn pink, or about* 8–10 *days before ready. Tree about* 45 *years old.*"—These cloves were similar in colour and general appearance to sample No. 1; they were, however, somewhat shorter, the average length being $\frac{9}{16}$ in.

No. 4. "*Stems from No.* 3."—This sample consisted of the stalks of the inflorescence from which the buds had been removed.

No. 5. "*Cloves picked when the buds are pink and ready for picking. Tree about* 60 *years old.*"—These cloves were considerably paler in colour and of brighter and better appearance than samples 1 and 3.

No. 6. "*Cloves picked when in full flower. Tree about* 60 *years old.*"—These cloves were deep brown in colour and had an average length of $\frac{11}{16}$ in. The corollas were absent.

No. 7. "*Mother of cloves from tree about* 60 *years old.*"—This sample consisted principally of clove fruits, but a considerable number of buds were also present. The average length of the fruits was $\frac{13}{16}$ in. and the width from $\frac{3}{16}$ to $\frac{3}{8}$ in. The buds, which were without corollas, averaged $\frac{7}{8}$ in. in length.

The following table shows the percentage of oil yielded by each of these products, and the results of the examination of the oils at the Imperial Institute:

Sample.	Yield of oil.	Specific gravity of oil at $\frac{15° C.}{15° C.}$	Optical rotation of oil at 22° C.	Eugenol in the oil.
	Per cent.			*Per cent.*
1 (Cloves)	17·8	1·056	−0°23′	89
2 (Clove stems)	5·9	—[1]	—[1]	—[1]
3 (Cloves)	19·2	1·064	−0°30′	88
4 (Clove stems)	6·3	1·050	−0°42′	89
5 (Cloves)	18·8	1·049	−0°29′	84
6 (Cloves)	17·4	1·050	−0°37′	88
7 (Mother of cloves)	6·5	1·056	−0°33′	90

[1] *The sample was too small to admit of this determination.*

The yields of oil from the samples are quite satisfactory, ordinary cloves yielding on the average about 18 per cent. and clove stems about 6 per cent. of oil.

On comparing the odours of the clove oils with that of a high-grade, standard, commercial sample of clove oil, it was found that the odour of No. 3 very closely resembled that of the standard oil, whilst the odours of the other oils were inferior to it, gradually becoming less pleasant in the order 5, 1, 6. The oils from the mother of cloves (No. 7) and from the stems (Nos. 2 and 4) were also decidedly inferior in odour to the standard clove oil, though No. 4 was superior to No. 2; the oil derived from the mother of cloves (No. 7) was the least pleasant of the series.

It is interesting to note that the order of the clove oils for odour is the same as that for yield of oil from the samples, viz. 3, 5, 1, 6. The same remark applies to the two clove-stem oils, Nos. 4 and 2.

The samples were submitted to brokers, who classified and valued them as follows; the quotations are ex-wharf, London terms, less 2½ per cent. discount (March 1914):

No.	Grade.	Value per lb.
1.	fair cloves	6*d.*
2.	fair clove stems	2½*d.*
3.	good small cloves	7*d.*
4.	good stems	2½*d.*
5.	good picked cloves	8*d.*
6.	headless cloves	5*d.*
7.	mothers	2½*d.*

The brokers stated that all the samples were of good quality in their different classes and represented products which would be readily saleable in the London market.

It is impossible to draw any definite conclusions from the results of the examination of a single series of samples, but it is noteworthy that sample No. 3, consisting of cloves picked just before the buds turn pink, yielded the highest percentage of oil, which moreover possessed the best aroma. The comparison with No. 5, collected at the usual stage, may, however, possibly be vitiated by the fact that No. 3 was from a tree about 45 years old, whereas No. 5 was from a tree about 60 years old.

In order to ascertain definitely the effect of picking the cloves at different stages of development it is desirable that samples should be collected from trees of the same age and not from trees of different ages. The effect of the age of

the tree could be determined by collecting series of similar samples from trees of different ages.

MILLETS

The following five samples of the smaller-seeded cereals which are known collectively as millets were received in May 1912:

No. 1. "Uimbe" (*Eleusine coracana*, Gaertn.).—These seeds were in good condition and free from insect attack, and the sample was clean and practically free from extraneous matter. A small quantity of unhusked seeds was present.

These seeds gave the following results on analysis, compared with those obtained in the case of a sample of *E. coracana* seeds from Uganda (this BULLETIN, 1909, 7, 151):

	Present sample. *Per cent.*	Sample from Uganda examined at the Imperial Institute. *Per cent.*
Moisture	10·3	14·0
Crude proteins	5·4	6·2
Consisting of:		
True proteins	5·2	—
Other nitrogenous substances	0·2	—
Fat	1·5	1·1
Starch, etc.	76·9	72·9
Fibre	3·4	3·0
Ash	2·5	2·8
Nutrient ratio [1]	1 : 14·9	1 : 12·2
Food units [2]	94	91·2

[1] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.*

[2] *The total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins.*

The seeds contained no cyanogenetic glucosides.

The sample of *E. coracana* seeds from Uganda was valued as a feeding-stuff at £4 10*s.* to £5 per ton in London in 1908 (*loc. cit.*). The Zanzibar product should sell at about the same rates.

No. 2. "Umanga" (*Setaria* sp.).—These seeds were plump, clean, in good condition and free from extraneous matter, and showed no signs of insect attack.

The seeds were examined with the following results

compared with those afforded by a sample of *S. italica* seeds analysed at the Koloniaal Museum, Haarlem:

	Present sample.	*Setaria italica* seeds analysed at the Koloniaal Museum, Haarlem.
	Per cent.	*Per cent.*
Moisture	9·47	8·60
Crude proteins	10·20	11·81
Consisting of:		
True proteins	8·32	—
Other nitrogenous substances	1·88	—
Fat	4·31	3·12
Starch, etc.	65·11	61·44
Fibre	7·83	12·38
Ash	3·08	2·65
Nutrient ratio	1 : 7·3	1 : 5·8
Food units	101·4	98·8

The seeds contained no cyanogenetic glucosides.

The sample was submitted to a firm of brokers in Liverpool, who considered it of fair quality, and valued it at about 26*s.* per 480 lb., less 2 per cent. discount, c.i.f. Liverpool (February 1913).

No. 3. "Mawali" (*Pennisetum typhoideum*, Rich.).—This sample consisted of unhusked seeds, which were plump and in good condition, dry, practically free from extraneous matter, and showing no signs of insect attack.

The seeds were examined with the following results, compared with the analysis of *P. typhoideum* seeds recorded by Church in *Food Grains of India*:

	Present sample.	Recorded by Church in *Food Grains of India.*
	Per cent.	*Per cent.*
Moisture	10·60	11·3
Crude proteins	12·47	10·4
Consisting of:		
True proteins	11·37	—
Other nitrogenous substances	1·10	—
Fat	5·00	3·3
Starch, etc.	67·13	71·5
Fibre	2·80	1·5
Ash	2·00	2·0
Nutrient ratio	1 : 6·3	1 : 7·6
Food units	110·8	105·7

The seeds contained no cyanogenetic glucosides.

This grain does not come on the English market

regularly, but consignments would probably realise about 22*s.* per 480 lb. (May 1913).

No. 4. "Mtama Maupe. Sorghum white" (*Sorghum vulgare*, Pers.).—This consisted of rather small seeds, which, however, were plump and in good condition. They showed signs of slight insect attack, but the sample was otherwise clean and practically free from foreign grain and extraneous matter.

No. 5. "Mtama Maikundu. Sorghum red" (*S. vulgare*).—This consisted mainly of rather small seeds of poor appearance. It had suffered slightly from insect attack, and contained a small amount of dust.

The sample of red Sorghum (No. 5) was analysed, with the results given in the following table, compared with analyses of *S. vulgare* grain from other sources:

	Present sample of red Sorghum.	India "dari."	Sudan "dura."
	Per cent.	*Per cent.*	*Per cent.*
Moisture	10·0	10·70	8·45
Crude proteins	11·2	7·75	13·06
Consisting of:			
True proteins	10·8	—	—
Other nitrogenous substances	0·4	—	—
Fat	2·8	3·03	3·30
Starch, etc.	72·1	74·36	72·45
Fibre	1·8	2·21	1·03
Ash	2·1	1·95	1·71
Nutrient ratio	1 : 7	1 : 10·5	1 : 6·1
Food units	107	101·3	113·3

The seeds contained no cyanogenetic glucosides.

The following prices of Sorghum were quoted recently in Liverpool (July 1914):

Syrian dari, 33*s.*—35*s.* per 480 lb.

Indian dari, 30*s.*—30*s.* 3*d.* per 480 lb.

A small consignment of Sudan dura was sold in London in November 1912 at £6 per ton.

Information regarding this grain, its market value, and its utilisation is given in this BULLETIN (1911, **9**, 253; 1913, **11**, 33).

LEGUMINOUS SEEDS

The following products of this kind were received in May 1912:

No. 1. "Kunde" (*Vigna Catjang*, Walp., cowpea).—These varied in colour from mottled yellowish-brown to purplish-brown. A small proportion of the seeds was mouldy, and the sample had been attacked by weevils. The sound seeds were well developed and of good appearance.

There is a small market for these seeds in the United Kingdom. A sample received at the Imperial Institute from Hong Kong (see analysis on p. 344) was valued in London in 1911 at £8 per ton.

No. 2. "Chooko" (*Phaseolus Mungo*, Linn., green gram).—The sample contained a small percentage of discoloured, mouldy, and shrivelled seeds, and had been slightly attacked by insects; it also contained a small amount of foreign grain. The sound seeds were plump and of good appearance.

A sample of *P. Mungo* seeds (green) from Hong Kong, in good condition, was valued by merchants at £6 15*s.* per ton c.i.f. United Kingdom ports when "gram" was quoted at £6 13*s.* per ton in Liverpool (see this BULLETIN, 1912, **10**, 236). In May 1913 "gram" was quoted in Liverpool at £6 16*s.* per ton.

No. 3. "Fiwi" (*Dolichos Lablab*, Linn.).—These beans varied in colour from yellowish-brown to purplish-brown. They were plump and on the whole in good condition, but about 8 per cent. had been attacked by insects, causing a slight amount of damage. A small amount of foreign grain was present.

A sample of *D. Lablab* beans from Hong Kong was submitted by the Imperial Institute in 1911 to brokers, who reported unfavourably on them, and stated that they would not readily find a market in London except at a low price (*loc. cit.*, p. 236).

No. 4 "Mbaazi" (*Cajanus indicus*, Spreng., white).—These beans were plump and well developed. About 25 per cent. showed signs of insect attack, but otherwise the sample was clean and practically free from extraneous matter.

No. 5. "Mbaazi" (*C. indicus*, black).—These beans resembled those of sample No. 4, but were a little smaller. About half of the sample had been attacked by insects, and a small percentage of foreign grain was present.

The seeds of *C. indicus* are known on the English market as "pigeon peas." A sample from Sierra Leone was valued in June 1910 at from £4 to £5 per ton in London for feeding purposes (this BULLETIN, 1910, **8**, 405). A sample from the Sudan was valued at from £5 10*s.* to £6 10*s.* per ton in September 1912, the higher price being due to a general rise in prices in the interval.

All the above samples represent well-known products, and they were therefore not analysed at the Imperial Institute. The following figures already recorded for samples of the same seeds from various countries may, however, be quoted for reference:

(1) *Vigna Catjang*

	From Hong Kong.	From the Sudan.	From India.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	11·65	7·95	12·7
Crude proteins	22·05	20·61	23·1
Fat	1·23	1·63	1·1
Starch, etc.	57·99	64·07	55·3
Fibre	3·83	2·76	4·2
Ash	3·25	2·98	3·6
Nutrient ratio	1 : 2·7	1 : 3·3	1 : 2·5
Food units	116·2	119·7	115·8

(2) *Phaseolus Mungo*

	From the Sudan.	From India.
	Per cent.	*Per cent.*
Moisture	8·02	10·1
Crude proteins	27·00	22·7
Fat	1·20	2·2
Starch, etc.	56·31	55·8
Fibre	3·83	4·8
Ash	3·64	4·4
Nutrient ratio	1 : 2·19	1 : 2·7
Food units	126·8	118·0

(3) *Dolichos Lablab*

	From Hong Kong.	From the Sudan.
	Per cent.	*Per cent.*
Moisture	12·63	7·40
Crude proteins	19·51	23·53
Fat	1·24	1·05
Starch, etc.	57·66	56·28
Fibre	5·89	7·95
Ash	3·07	3·79
Nutrient ratio	1 : 3·1	1 : 2·5
Food units	109·5	127·7

(4) and (5) *Cajanus indicus*

	From the Sudan.	From Sierra Leone.
	Per cent.	*Per cent.*
Moisture	7·49	9·1
Crude proteins	20·11	18·1
Fat	1·66	1·0
Starch, etc.	60·58	61·8
Fibre	6·21	6·4
Ash	3·95	3·6
Nutrient ratio	1 : 3·2	1 : 3·5
Food units	115·0	109·5

No. 6. "Njugu Mawe" (*Voandzeia subterranea*, Thou.).—The sample consisted mainly of yellow beans, but a few purple, brown, and black beans were present. The beans were plump, but about 70 per cent. had been attacked by insects, although in the majority of cases the damage was not extensive. The sample contained a few broken beans and foreign grains.

These beans were analysed with the following results, compared with those of the examination at the Imperial Institute of a previous sample from Northern Nigeria (this Bulletin, 1909, **7**, 151):

	Present sample.	Previous sample from Northern Nigeria examined at the Imperial Institute.
	Per cent.	*Per cent.*
Moisture	7·8	13·1
Crude proteins	19·1	16·0
Consisting of:		
True proteins	18·0	—
Other nitrogenous substances	1·1	—
Fat	6·5	6·2
Starch, etc.	58·9	58·4
Fibre	4·2	3·9
Ash	3·5	2·4
Nutrient ratio	1 : 3·9	1 : 4·5
Food units	123·0	113·9

The seeds contained no cyanogenetic glucosides.

The sample from Northern Nigeria previously examined at the Imperial Institute was submitted to a firm of manufacturers of feeding-cakes, who stated that they could not find that the seeds had ever been used in the United Kingdom (*loc. cit.*) and did not consider that they would have a very high commercial value as a feeding-stuff for cattle. The

seeds are, however, a useful foodstuff, and their cultivation for local use might be encouraged in districts where more valuable leguminous crops, such as the true ground nut and the soy bean, cannot be remuneratively grown.

Oil-Seeds

Para Rubber Seed

A sample of Para rubber seeds was received in April 1913. They had the ordinary appearance of the seeds of *Hevea brasiliensis*, but were larger than is usually the case. They consisted of husk 56 per cent. and kernel 44 per cent.

The kernels contained 7·1 per cent. of moisture, and, on extraction, furnished 45 per cent. of oil, which is about the usual yield for the kernels of Para rubber seed. The oil was clear, golden yellow in colour, and deposited a little "stearin" on standing. It was examined with the following results compared with those previously recorded at the Imperial Institute:

	Present sample.	Results previously recorded at the Imperial Institute.
Acid value	42·7	10·7 to 29·9
Saponification value	198·8	185·6 „ 195·7
Iodine value . . *per cent.*	136·0	121·2 „ 136·2

The oil was rather acid, but otherwise had the usual characters of Para rubber seed oil.

Para rubber seed should be decorticated in the country of origin and the kernels alone shipped to Europe. If carefully dried in the sun and shipped in bags these Zanzibar kernels would probably realise about £10 per ton in the United Kingdom (August 1913).

Further information regarding the value and commercial utilisation of Para rubber seed kernels is given in this Bulletin (1903, **1**, 156; 1904, **2**, 22; 1909, **7**, 95; 1911, **9**, 35; 1913, **11**, 551).

Sesamum Seed

Two samples of sesamum seed were received in May 1912.

No. 1. *White Sesamum.*—This consisted of small, plump seeds, of dark cream colour and of somewhat dirty appearance. The sample was slightly dusty.

The seeds yielded 53·8 per cent. of oil, which had the usual appearance of sesamum oil.

No. 2. Black Sesamum.—These were small, very dark brown seeds, many of which were rather flat, while some were quite immature. The sample was rather dusty.

The seeds yielded 49·1 per cent. of oil, which had the usual appearance of sesamum oil.

The present price of sesamum seed in the United Kingdom is from 56*s.* to 60*s.* per quarter (384 lb.), and in Marseilles 42·50 to 57 francs per 100 kilos (June 1914). The black seed is somewhat less valuable than the white.

An account of the cultivation, production, and utilisation of sesamum seed appeared in this BULLETIN (1911, **9**, 259).

Kapok Seed

This sample, which was received in April 1913, consisted of small brownish-black seeds, with the usual appearance of *Eriodendron anfractuosum* seeds.

The seeds contained 12·7 per cent. of moisture, and on extraction furnished 21 per cent. of oil, which is a normal yield. The oil was clear, brownish-yellow in colour, and possessed a faint smell.

It was examined with the following results:

Specific gravity at $\frac{15·5° C.}{15·5° C.}$	0·914
Acid value	26·0
Saponification value	194·2
Iodine value . . . . . *per cent.*	101·5

The seed represented by this sample should be saleable in Europe at the current price if marketed in commercial quantities. Kapok seed in Java was worth at the time of the report £4 10*s.* to £4 16*s.* per ton, and its value in Rotterdam, which is the principal European market for this product, was about £6 10*s.* per ton (August 1913).

Jatropha Curcas Seed

A sample of "mbono" seed (*Jatropha Curcas*, Linn.) was received in May 1912.

The seed was in good condition, and had the usual

appearance of *J. Curcas* seed; a few broken seeds and kernels without shells were present. The seeds consisted of shell 33·7 per cent. and kernel 66·3 per cent. The latter yielded 51·2 per cent. of oil, equivalent to a yield of 33·9 per cent. from the entire seeds.

A market could no doubt be found for this seed, but so far it has not been produced in quantities large enough to warrant large-scale trials being made with it in the United Kingdom. An account of the seed and of the oil which it yields was given in this BULLETIN (1904, **2**, 170).

Ground Nuts

A sample of "njugu Nyassa" nuts (*Arachis hypogaea*, Linn.) was also received in May 1912.

The nuts were medium-sized and in very poor condition, the shells being covered with a thin coating of earthy matter, whilst a large proportion of the kernels were mouldy. The nuts consisted of shell 28 per cent. and kernel 72 per cent. The latter yielded 52·0 per cent. of oil, which is a normal yield (see this BULLETIN, 1910, **8**, 153). The oil had the usual appearance of ground-nut oil.

Ground nuts in the condition of this sample from Zanzibar would probably not be readily saleable in Europe at good prices, but nuts with clean shells and well-dried kernels free from mould would find a ready market for edible purposes.

Moringa pterygosperma Seeds

A sample of "mronge" seed (*Moringa pterygosperma*, Gaertn.), was received at the same time as the preceding sample.

The seeds were pale brown and round, with three papery "wings." The seed consisted of shell 39 per cent. and kernel 61 per cent. Some of the kernels were mouldy. The yield of oil from the kernels was 28·6 per cent. The oil had the usual character of *M. pterygosperma* oil.

The yield of oil from the kernels of these seeds is somewhat low, as a previous sample from Northern Nigeria examined at the Imperial Institute contained 38 per cent.

of oil in the kernels. The low yield in the present case may perhaps be due to the presence of mouldy kernels.

The results of the examination at the Imperial Institute of previous samples of Moringa seed and Moringa-seed oil were given in this BULLETIN (1904, **2**, 117). Further samples of the seed and oil have also been examined by commercial and technical experts. From these investigations it appears that the seed would be saleable in Europe if obtainable in quantity, but that its value is at present rather doubtful owing to the fact that it is uncertain whether the residual cake can be used as a feeding-stuff. If this were the case the seeds would probably realise from £7 to £8 per ton in the United Kingdom. The cake, however, has been found to contain traces of an alkaloid, and also a large quantity of non-albuminoid nitrogenous matter, and it may consequently be found unsuitable for use as a feeding-stuff.

The oil could be used for soap-making, and for this purpose would probably have a somewhat lower value than cotton-seed oil, which is at present worth from 32*s.* to 34*s.* per cwt. in Liverpool (June 1914). At one time the oil was used to some extent for lubricating delicate machinery, such as clocks, etc., but recent trials have shown that it is not particularly suited for this purpose, for which it is now superseded by sperm oil.

Castor Seed

A sample of castor seed ("mbarika") was received at the same time as the preceding sample. It consisted of small, dark, greyish-brown, mottled seed in good condition.

The present price of Bombay castor seed in the United Kingdom is £10 17*s.* 6*d.* per ton (June 1914), and this Zanzibar seed would probably fetch about the same price if exported in good condition.

Oil-Palm Nuts

A sample of oil-palm nuts, known locally as "mchikichi," was received in May 1912. The nuts were rather small, with shells of medium thickness. They consisted of shell 61 per cent. and kernel 39 per cent.

The kernels furnished 52·7 per cent. of oil, representing a normal yield (see this BULLETIN, 1909, **7**, 390; 1913, **11**, 206). This product had the usual appearance of palm-kernel oil.

Undecorticated palm nuts such as those in the present sample would be unsaleable in Europe, but the dried kernels freed from the shells would realise the ordinary market price of palm kernels, the current value of which is £18 to £19 2*s*. 6*d*. per ton, less 5 per cent. ex quay Liverpool (June 1914).

SEED OF *CAESALPINIA BONDUCELLA*, FLEMING

The seed which is the subject of this report was received in May 1912.

The sample consisted of more or less spherical seeds, about ¾ in. in diameter, and varying in colour from pale grey to slate grey; a few brown seeds were also present. The shell was hard, and enclosed a nearly white starchy kernel which was intensely bitter.

These seeds are the "Haba de San Antonio" of the Mexican Pharmacopœia. They are stated to be used in Mexico as a tonic and antiperiodic, their activity being ascribed to the presence of an ill-defined bitter principle known as "bonducin" or "guilandinin," which, when administered in doses of 10 to 20 centigrams, is alleged to be as effective as quinine. The kernels have also been stated to contain an alkaloid and about 20 per cent. of a fatty oil.

There is no demand for this seed in Europe.

COIR ROPE AND MATTING

Samples of coir rope and matting, made in the Zanzibar prisons, were received for examination in July 1912.

The samples were submitted to a large firm of matting and rope importers, who reported that the rope was very well made, being level spun, regular and of good colour, and that they were of opinion that there would be a good market in the United Kingdom for such rope. They stated that the principal sizes of coir rope used in the United Kingdom are from 1½ in. to 3 in. in circumference, and that for this market the rope should be put up in coils of 60 fathoms,

with a small piece of gunny attached to the coil and bearing the shipping mark.

The firm pointed out that this rope from Zanzibar is only three-strand, whereas the coir rope shipped from Cochin is always four-strand.

With reference to the matting, the firm reported that the usual widths imported into the United Kingdom are 18 in., 19 in., 36 in., 45 in., 54 in., and 72 in., and that the material is put up in pieces of 25 and 50 yards.

A trial consignment of coir rope and matting was received for sale in London in May 1914. The former was sold at the rate of 20*s.* per cwt., and the matting at 8*d.* per square yard. The prices which these materials realise in Zanzibar are 15*s.* per cwt. and 1*s.* 4*d.* per square yard respectively.

Seaweed

The seaweed which is the subject of this report was received in February 1913. The weed was stated to occur plentifully on the north of Zanzibar Island, and it was desired to ascertain its value as a manure for coconuts.

The sample consisted of dry, papery fronds, about half an inch wide. Most of the fronds bore a surface incrustation of calcium carbonate.

The weed as received at the Imperial Institute was found to contain:

		Per cent.
Moisture	H_2O	20·72
Nitrogen	N	0·76
Ash (containing much sand)		30·26

The ash was submitted to partial analysis with the following results:

		Expressed on the ash.	Expressed on the original weed.
		Per cent.	*Per cent.*
Lime	CaO	15·86	4·79
Magnesia	MgO	7·84	2·37
Potash	K_2O	1·82	0·55
Soda	Na_2O	14·31	4·33
Sulphuric acid	SO_3	6·49	1·96
Phosphoric acid	P_2O_5	0·36	0·11
Chlorine	Cl	15·93[1]	4·82

[1] *Equivalent to* 26·3 *per cent. of sodium chloride.*

These results show that this seaweed from Zanzibar contains much lower percentages of nitrogen, potash, and phosphoric acid than certain seaweeds belonging to the genera Fucus and Laminaria. The weed would be useful as a manure for soils on which coconuts are grown, but the proportion of potash is low, and as this constituent is of considerable importance to coconuts it would be necessary to apply to the soil, in addition, some form of manure rich in potash.

WHEAT FROM THE SUDAN

WHEAT growing in the Sudan has increased steadily during recent years, but the area devoted to this crop is still very small in comparison with that devoted to dura (*Sorghum vulgare*), the staple foodstuff of the country, as is shown in the following table:

	1910.	1911.	1912.
	Feddans.	*Feddans.*	*Feddans.*
Wheat	19,681	26,972	29,193
Dura	1,192,883	835,126	1,187,038

1 *feddan* = 1·038 *acre.*

The wheat is grown almost entirely under irrigation, either artificial or flood; it was grown as a rain crop on only 176 feddans in 1910, on twenty feddans in 1912, and there was none at all grown in this way in 1911. At present wheat is cultivated chiefly in the Dongola and Berber Provinces, and it is thought that its cultivation may increase somewhat on the riverain estates of these Provinces, as well as on those of Khartoum and Halfa Provinces, and that it will certainly do so to some extent in the basin area of Dongola as the irrigation schemes become perfected. Good crops can be grown in the Gezira, south of Khartoum, where an extensive irrigation scheme is in progress.

At the present time the production of wheat in the Sudan does not meet the local demands, and considerable

quantities of wheat and flour are imported, the statistics for recent years being as follows :

	1911.		1912.		1913.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	lb.	£	*lb.*	£	*lb.*	£
Wheat . .	1,058,639	4,471	5,729,369	23,608	3,807,218	16,062
Flour (wheat) .	16,552,104	79,010	17,420,328	88,412	18,230,983	89,983

Experimental work with wheat is being carried on at a number of the experimental and demonstration stations which are under the control of the local Department of Agriculture, and three samples of wheat grown under irrigation at the Gezira Agricultural Experimental Station at Tayiba were received for examination at the Imperial Institute in July 1913.

The samples were as follows:

No. 1. "*Egyptian Wheat.*"—This sample contained a small proportion of earth and grit. The grains of wheat were in good condition, and fairly large and plump; some were translucent and others white and opaque. The flour yielded by this wheat had a slight but distinct yellow tint.

No. 2. "*Dongola Wheat.*"—This sample contained a quantity of earth and grit, but it was otherwise in good condition. The grains were of medium size, and were semi-translucent. The wheat gave a flour of a rather dirty white appearance.

No. 3. "*Indian Wheat.*"—This sample also contained a little earth. The grains were of medium size and in good condition; some were white and opaque, and others were semi-translucent. The wheat yielded a flour with a yellowish tinge.

The samples were submitted to chemical examination with the following results :

	1. "Egyptian."	2. "Dongola."	3. "Indian."
	Per cent.	*Per cent.*	*Per cent.*
Moisture	10·6	9·7	10·2
Total protein	10·5	11·8	8·7
Gluten	9·0	11·9	7·0
Gliadin	3·8	4·9	3·1

The three wheats were submitted for milling and baking trials to Mr. A. E. Humphries, who reported that all the samples were very dirty and contained an unreasonably large percentage of grit. The three lots were cleaned, conditioned, and milled, and baking trials were subsequently made. As a result of these tests it was found that the samples behaved on the whole in a similar manner to average Indian wheats as now met with in commerce. The "Dongola" wheat was the least attractive in appearance, and consisted of a mixture of naturally mellow and naturally hard wheats. The latter fact is a great disadvantage from the miller's point of view, as hard wheats require to be conditioned quite differently from naturally mellow wheats, and if the two are mixed together before that stage in milling has been reached it is impossible to obtain the best results. It was found, however, that in spite of its mixed character and the presence of much dirt, the sample of "Dongola" wheat yielded the best flour of the three.

Samples 1 and 3 were very similar, but the expert preferred No. 1 ("Egyptian"), which he stated nearly resembled in baking quality ordinary Choice White Kurrachee wheat.

The expert pointed out that each of the three samples appeared to consist of more than one variety of wheat, and although the separation of the different varieties was more particularly desirable in the case of the "Dongola" sample, the other two wheats would also require some sorting out. He suggested that in further cultivation experiments each variety thus separated should be grown as a distinct type of wheat, with a view to ascertaining which is the best.

It was pointed out in the report that it is very desirable, if Sudan wheats are to be exported to the United Kingdom, that they should be shipped in a much cleaner condition than the present samples. Indian wheats are now sold in the United Kingdom on "clean terms," and since these terms have been instituted the relative value of Indian wheat has appreciated considerably.

PEAS AND BEANS FROM BURMA

The *Phaseolus lunatus* beans at present shipped from Burma to this country and the Continent are of two kinds, known respectively as "red" and "white" Rangoon beans. The former yield minute and usually harmless amounts of prussic acid when ground into meal and mixed with water, and the "white" beans generally yield none or mere traces of prussic acid under like conditions (see this Bulletin, 1912, **10**, 654). Although, so far as is known, no harm has arisen from the use of the red beans they are regarded with some suspicion by agricultural experts in Europe, and they realise comparatively small prices in the markets. In 1912 the red Rangoon beans realised only about £6 per ton in this country and in Europe, whilst white Madagascar beans, which are used for human food, were fetching over £24 per ton. In view of these facts the Imperial Institute in consultation with merchants in London suggested to the Department of Agriculture in Burma that steps should be taken to encourage the natives to cultivate a better class of beans for export, and a sample of white Madagascar beans of the kind in demand in this country was forwarded to the Department for trial cultivation. The merchants who were consulted also pointed out that the peas at present grown in Burma are practically valueless on the London market, and they suggested that experiments should be made in the cultivation of "Victoria" peas and "Green" peas. Samples of these were also therefore forwarded by the Imperial Institute to Burma for trial. The results of these trials are given in the *Report of the Mandalay Agricultural Station, Burma, for the year* 1912–13.

The experiments were carried out at the Natywagon Experimental Area on a fine, easily worked, sandy loam which had previously been used for the cultivation of indigenous beans and which was typical of the soils selected for the cultivation of these crops by Burmans in the riverine tracts of the country.

The Madagascar beans were sown on low ridges, and,

the season being late and exceptionally dry, the plants had to be watered once a week until they were a foot high. Although 9 lb. of seeds (numbering about 3,000) were sown, only 350 plants reached maturity, and these yielded a total crop of 41¼ lb. of seed. The plants branched freely and exhibited a habit similar to that of the red Rangoon bean ("pe-gya"), but were almost twice as large. Like pe-gya the Madagascar beans proved to be continuous bearers which necessitated the pods being gathered as they ripened, at intervals varying with the dryness of the season; this disadvantage they exhibited to a greater degree than pe-gya.

The Victoria peas did better than the Green peas, but revealed no feature of special value over the Burmese "sadaw-pe" which is already commonly grown. From 2 lb. of Victoria peas sown, 12 lb. of seed were reaped. The Green peas were attacked by a pod-borer which destroyed the greater part of the crop, and only 2 lb. of seed were reaped from the 2 lb. of seed sown.

Experiments were also made at Natywagon with a view to selecting an indigenous variety of Rangoon bean which would give a low yield of prussic acid, and at the same time would be suitable for cultivation in Burma. The types used in these experiments were selected from the pe-gyas received from Madaya (Mandalay District), Kyauksé, Mônywa, Katha, Tharrawaddy, and Falam (Chin Hills), and consisted of beans which varied in colour from a pale buff through mottled purple to deep red and even black. The seeds of all the beans which were reaped were lighter in colour than the seeds sown. The only variety of white Rangoon bean ("pe-byu-gale") experimented with was obtained from the Mandalay District. In this case, the reaped seeds had an appearance identical with that of the seed sown.

Specimens of the Madagascar beans, Victoria peas, and of certain of the indigenous beans produced in the course of these experiments were received at the Imperial Institute for examination in May 1913. The descriptions supplied by the Deputy Director of Agriculture, Northern Circle, Burma, were as follows:

Number of sample.	Name.	Description of seed from which sample was grown.	Origin of seed.	Remarks.
1	Pe-byu-gyi (Madagascar bean)	Ordinary seed without selection	Imperial Institute	Yield per acre 820 lb. only. The seed was received too late for a proper test of yield to be made. Prospects good.
2	Sadaw-pe (Victoria pea)	ditto	ditto	Yield very poor. Sown too late. Prospects not good.
3	Pe-byu-gale (Rangoon white bean)	The common white *Phaseolus lunatus* of Burma	Low country	This is the same throughout the country. Only grown in the plains.
4	Pe-gya (red bean)	Seed of a light colour only	ditto	ditto
5	ditto	Seed of a dark colour only	ditto	ditto
6	ditto	Mixed seed as received from the districts	ditto	ditto
7	Tim Sin	Seed of a black colour	Chin Hills	Grown on the Chin and adjacent hills only.
8	Kawl-be	Seed of a red colour only	ditto	ditto
9	ditto	Seed of a light colour	ditto	ditto
10	ditto	Mixed seed as ordinarily cultivated by the Chins	ditto	ditto

The results of the examination of the samples at the Imperial Institute are given below:

No. 1. *Madagascar beans* (*pe-byu-gyi*).—Large, white, kidney-shaped beans, from 0·7 to 0·9 in. long, plump and of good appearance.

No. 2. *Victoria peas* (*sadaw-pe*).—Small, rounded, creamy-brown peas, ¼ in. in diameter, plump, and of good appearance.

No. 3. *Pe-byu-gale.*—Small white beans similar to the white Burma or Rangoon beans of commerce.

No. 4. *Pe-gya* (*light*).—Beans of pinkish-cream to pinkish-brown colour; a few were marked with very slight purplish-pink specks.

No. 5. *Pe-gya* (*dark*).—Purplish-pink beans with pale brown specks or patches.

No. 6. *Pe-gya* (*ordinary*).—Coloured beans which could be separated into three groups: (1) pinkish-cream to pinkish-brown; (2) same as (1) but with purplish-pink specks or patches; and (3) purplish-pink with light specks or patches.

No. 7. Tim Sin (black).—Beans of uniform black colour, except at the hilum, which was nearly white.

No. 8. Kawl-be (red).—Beans of uniform dark purple colour.

No. 9. Kawl-be (light).—These beans were on the whole very similar in appearance to No. 4 (pe-gya light).

No. 10. Kawl-be (ordinary).—Beans showing all the colours of samples 7, 8, and 9, and bearing specks and patches. Only a few were of uniform purple colour.

The beans of samples 3 to 10 were similar in shape and size; they were of rounded oblong shape, tapering at one end, and measuring approximately 0·4 in. in length. They were plump and of good appearance. The hilum was in all cases nearly white.

All the samples were clean, in good condition, and practically free from insect attack.

The samples were submitted to chemical examination, and the percentage of prussic acid which they yielded, expressed on the peas and beans as received, is shown in the following table:

No.	Variety.	Yield of prussic acid. *Per cent.*
1.	Madagascar beans	0·005
2.	Victoria peas	nil
3.	Pe-byu-gale	0·03
4.	Pe-gya (light)	0·015
5.	„ (dark)	0·01
6.	„ (ordinary)	0·04
7.	Tim Sin (black)	0·03
8.	Kawl-be (red)	0·05
9.	„ (light)	0·055
10.	„ (ordinary)	0·04

The Madagascar beans and Victoria peas were submitted to the firm of merchants in London who originally supplied the seed from which they were grown. The firm reported on the samples as follows:

(1) The Madagascar beans are of good quality, though some of them have a slight yellow tinge; if the standard of this sample were maintained the beans should realise the ordinary price of Madagascar beans. The "spot" price of the latter in London at the date of report

(September 1913) was 23*s.* per cwt., and that for "forward shipment" 18*s.* per cwt.

(2) The Victoria peas are also of good quality, but rather smaller than the seed from which they were grown. The value of the sample was £8 to £10 per ton in London (September 1913).

No valuations of the other beans (samples 3 to 10) were obtained, as they are at present only of interest in connection with the selection experiments which are in progress in Burma.

The merchants who examined the samples of Madagascar beans and Victoria peas included in this series appeared to be satisfied with the quality of these products, and it will be interesting to see whether the standard will be maintained in the future. The Madagascar beans of commerce yield as a rule very little prussic acid or none at all. The sample of Madagascar beans sent from the Imperial Institute, and from which this present sample was grown, gave 0·0025 per cent. of prussic acid; and the sample grown in Burma yielded, as shown above, just twice as much. Even this amount, however, is only half that present in the best sample of Burma beans described above (Pe-gya No. 5), which yielded 0·01 per cent. of prussic acid. It will be of interest to note how the future samples of Madagascar beans grown in Burma will behave in this respect.

The beans produced by selection experiments with Rangoon beans have afforded interesting results. The white Rangoon beans yielded 0·03 per cent. of prussic acid, which is high for the variety, though not higher than has been recorded for this kind in recent years. As regards the coloured Rangoon beans, it is noticeable that sample No. 6, consisting of ordinary mixed pe-gya beans, yielded more prussic acid than the two samples of uniformly coloured beans (Nos. 4 and 5) obtained by selection. No general conclusions can, however, be drawn from this, since the reverse is the case with the samples of "ordinary mixed" (No. 10), and "selected uniform" (Nos. 8 and 9) kawl-be beans.

It was pointed out in the report on these samples that

it is very desirable that the experiments should be continued, with a view to the isolation of pure races of these beans, and that when this has been done further experiments should be carried out in order to ascertain the effect of locality, soil, and seasonal variations in climate on the cyanogenetic behaviour of the races.

At the request of the Department of Agriculture in Burma, two tons of Madagascar beans have been forwarded for experimental cultivation by sundry co-operative societies in the Province. By this means the beans wil' be tested on an extended scale, and their value for general cultivation throughout the country should thus be definitely ascertained.

TIMBERS FROM VARIOUS COUNTRIES

In the following pages an account is given of the results of examination of several timbers from parts of Africa and from British Guiana, which have been received recently at the Imperial Institute.

Teak from Nigeria

Plantations of teak (*Tectona grandis*, Linn.) have been made in a number of the forest reserves in the Southern Provinces, Nigeria. So far the results have been very promising, and the trees have grown well, but none of them are at present old enough to supply large timber. Samples of the wood obtained from a specimen tree, twenty-six years old, grown at the Ebute Metta Gardens, were forwarded to the Imperial Institute in May 1912 in order that its mechanical properties and working qualities might be determined. The tree was not growing under very favourable conditions, as the soil was impregnated with salt and was exposed at spring tides to the influence of salt water. Three pieces of the timber, marked A, B, and C, were supplied, and these were examined with the results given in the following pages.

Working Qualities

The wood was fairly well seasoned, and specimen pieces showed little sign of warpage or shrinkage after cutting.

In colour, texture, and markings the wood is very like East Indian teak and would be difficult to distinguish from the latter. It also works similarly to East Indian teak with all machine and hand tools, being hard, moderately tough, and strongly bound together by numerous fine medullary rays. It unites excellently with glue, and takes a good polish which brings out the colour well.

Some portions of the wood contained rather frequent knots and the grain was generally irregular in consequence, but other pieces were freer from knots and worked cleaner.

If the timber could be supplied in bulk similar to the latter pieces, it could be used for any purpose for which East Indian teak is employed.

Mechanical Properties

The mechanical properties of the timber have been determined for the Imperial Institute by Prof. W. E. Dalby, F.R.S., of the City and Guilds (Engineering) College, who has furnished the following report:

Description of the Wood.—The wood was received in the form of three logs, from which the following test pieces were cut:

(1) 10 beams 3·75 in. × 3·75 in. section and 42 in. long.

(2) 20 blocks 3·75 in. × 3·75 in. section and 6 in. long.

(3) 6 pieces for shearing tests (see p. 364).

The 10 beams were tested in bending with a single load in the centre.

The 20 blocks were tested to failure in compression.

The remaining pieces were tested in shearing until they failed.

The wood is of greenish-yellow colour, not unlike Burma teak, but it has not the same characteristic smell; it is a much drier wood and there appears to be no oil in the fibres. It is fairly free from knots, wanes, and shakes, etc., and judging from looks only would appear to be quite excellent wood; on test, however, it does not come out so well. The density appears to be somewhat lower than that of ordinary teak (Indian), being 45 lb. per cubic foot

average, while Indian teak appears to average about 49 lb. per cubic foot. The strength also appears to be rather below that of the Indian teak.

The average percentage of volatile matter, driven off on heating the wood at 105° C. was 11·2, calculated on the original weight of the wood.

Bending Tests to Destruction.—These tests were carried out on a small 10-ton screw-loaded Buckton testing machine, arranged so that a measured central load could be applied on a span of 36 in., which was kept constant in all cases.

The beams were measured and then placed singly in the machine. A telescope was arranged to focus on a scale affixed to the beam; then loads increasing by 500 lb. at a time were applied and the scale-reading noted, this being continued until fracture took place.

Plotting the scale-reading against the corresponding load gives a curve which is initially straight but departs from the straight line above certain values, and the value at which the curve falls away from the straight is taken to be the elastic limit of the beam.

From the deflection at the elastic limit the modulus of elasticity can be calculated.

The modulus of rupture (coefficient of transverse strength) is obtained from the breaking load.

Thus we have:

(*a*) Modulus of elasticity $= E = \frac{WL^3}{4BH^3\delta}$ lb. per sq. in.

where $W =$ elastic limit (lb.); $L =$ span (inches); $B =$ breadth; $H =$ height; $\delta =$ deflection (inches).

(*b*) Modulus of rupture $= \frac{3W'L}{2BH^2}$ lb. per sq. in., where $W' =$ the breaking load in lb.

Table I. (p. 363) gives the results of the bending tests.

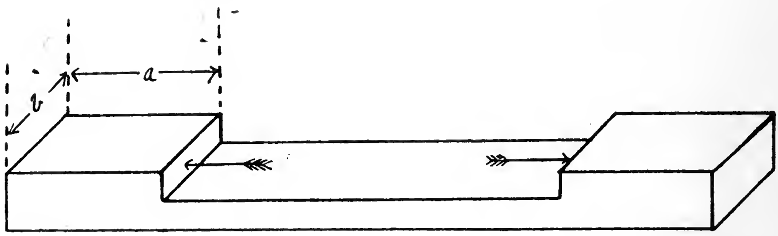
Compression Tests.—The blocks were tested and crushed to destruction in a 100-ton Buckton testing machine arranged for compression. In all cases the appearance of the block before testing was noted, and also the breaking load. All blocks were carefully measured before testing.

Table I. Bending Tests.

Test piece cut from	Breadth. *Inches.*	Depth. *Inches.*	Span. *Inches.*	Density. *lb. per cub. ft.*	Modulus of rupture. *lb. per sq. in.*	Elastic load up to *lb.*	Stress at elastic limit. *lb. per sq. in.*	Modulus of elasticity. *lb. per sq. in.*	Remarks.
Log A	3·79	3·94	36	45·1	9,200	6,900	6,900	1,160,000	Very knotty piece; mostly heart wood; pith along one side.
Log B	3·77	3·77	36	45·4	11,370	7,250	7,340	1,295,000	Very knotty specimen; sap and heart wood.
do.	3·77	3·75	36	43·6	11,720	6,500	6,650	1,500,000	Cracked initially; mostly heart wood; pith along one side.
do.	3·77	3·77	36	43·5	12,050	8,500	8,570	1,290,000	Sound before test; heart and sap wood.
do.	3·78	3·77	36	43·8	7,550	3,000	3,020	960,000	Bad knot at centre; unsound in middle; heart wood; pith along one edge.
do.	3·76	3·78	36	45·0	12,000	9,000	9,014	1,287,000	Very dry wood; beam sound before test; brittle fracture.
do.	3·75	3·78	36	45·4	11,370	7,250	7,340	1,295,000	Sound before test; heart and sap wood; white marks along grain.
Log C	3·76	3·75	36	42·3	4,600	—	—	1,030,000	Cracked before testing; knotty.
do.	3·76	3·78	36	43·5	10,050	6,050	6,050	1,400,000	Sound before test; partly sapwood; white marks along grain.
do.	3·77	3·77	36	43·8	12,050	8,050	8,050	1,450,000	Sound before test; small knots; mostly heart wood.

Table II. (p. 365) gives the results of the tests.

Shearing Tests.—The test pieces, of the shape shown in the figure, were arranged in the small 10-ton Buckton testing machine so that the load was applied in the directions indicated by the arrows.



Each specimen was tested to destruction and the breaking load noted. All specimens were carefully measured before testing.

The following table gives the results obtained:

Test piece cut from	Top a. × b. *Inches.*	Bottom a. × b. *Inches.*	Shearing area. *Sq. inches.*	Density. *lb. per cub. ft.*	Place of fracture.
Log A	1·96 × 2·07	1·98 × 2·07	4·04	48·8	Top
do.	1·99 × 2·06	1·97 × 2·07	4·08	47·1	Top
Log B	1·99 × 2·08	1·98 × 2·04	4·04	43·4	Bottom
do.	2·05 × 2·04	2·02 × 2·02	4·09	45·0	Bottom
Log C	1·95 × 2·06	1·98 × 2·07	4·08	42·6	Bottom
do.	1·92 × 2·06	2·03 × 2·07	4·18	46·2	Bottom

Test piece cut from	Shearing load. *lb.*	Shearing stress. *lb. per sq. in.*	Remarks.
Log A	5,080	1,260	Failed in shear proper.
do.	3,590	—	Failed in tension at knot; knot along top end at right angles to length.
Log B	4,330	1,070	Failed in shear proper.
do.	5,130	1,260	Failed in shear proper.
Log C	4,610	1,130	Failed partly in shear and also in tension.
do.	3,860	920	Failed in shear proper.

Remarks on the Results of the Mechanical Tests

It will be seen from the preceding tables that the results of the mechanical tests on the different test pieces show considerable variation, and the following comments may be offered:

Transverse Tests.—The values for the coefficient of transverse strength (modulus of rupture) range from 4,600 to 12,050 lb. per square inch in the different specimens, but eight of the ten pieces tested gave values of over 9,000 lb.

Table II. Compression Tests.

Test piece cut from	Width. *Inches.*	Depth. *Inches.*	Height. *Inches.*	Weight. *lb.*	Density. *lb. per cub. ft.*	Breaking load. *lb.*	Breaking stress. *lb. per sq. in.*	Remarks.
Log A	3·73	3·78	6·09	2·375	48·6	98,000	6,860	Knot at lower end.
do.	3·67	3·93	5·99	2·156	44·0	103,000	7,100	Sap wood and pith at sides.
do.	3·93	3·68	6·07	2·500	50·0	81,800	5,600	Pith on one side.
do.	3·75	3·75	6·03	2·375	49·0	80,000	5,600	Knot on one side.
Log B	3·78	3·78	6·20	2·810	55·6	103,000	7,200	Sound before test.
do.	3·77	3·77	6·10	2·500	50·5	98,000	3,850	Diagonal crack across end before test.
do.	3·77	3·77	6·00	2·125	43·7	96,000	3,800	Sap wood at one corner.
do.	3·80	3·80	6·02	2·125	43·0	106,000	7,050	Sound before test.
do.	3·77	3·82	6·08	—	42·5	95,000	6,600	Curly grain with knot at one side; pith down one edge with crack radiating to centre.
do.	3·83	3·90	6·09	—	46·0	71,300	2,800	Very knotty and unsound near knot before test.
do.	3·88	3·89	6·06	—	40·8	103,000	6,800	Sound but for small crack near corner before test.
do.	3·83	3·89	6·05	—	43·4	97,000	6,500	Sound before test, but knotty.
Log C	3·77	3·77	6·07	2·063	42·0	83,000	5,850	Knot at lower end.
do.	3·80	3·80	6·05	2·344	47·2	94,000	6,550	Sound before test.
do.	3·78	3·77	6·07	2·063	42·0	85,000	6,000	Crack at one end before test.
do.	3·78	3·77	6·02	2·344	48·0	93,000	6,600	Sound before test.
do.	3·78	3·76	6·04	—	47·3	90,000	6,330	Sound before test.
do.	3·77	3·79	6·09	—	43·5	70,500	4,940	Bad double crack down one side before test.
do.	3·78	3·77	6·04	—	45·5	83,000	5,800	Sound before test.
do.	3·80	3·81	6·03	—	41·8	72,400	5,000	Crack on one side before test.

In the case of the two lowest values, 4,600 and 7,550 lb. respectively, the test pieces were not very satisfactory.

The highest value found for the Nigerian teak is, however, very much lower than the average value given by a number of specimens of Burma teak tested in India (see tables below).

Compression Tests.—The results of these tests also show considerable variation, the values obtained ranging from 2,800 to 7,200 lb. per sq. in. in the different specimens. Sixteen of the twenty test pieces, however, gave values of 5,000 lb. or over. The highest result, viz. 7,200 lb. per sq. in., is approximately equal to the maximum values given by specimens of Burma teak, but the range is much greater in the Nigerian teak than in the Burma teak (see tables below).

Shearing Tests.—It will be observed that all but one of the test pieces failed in shear proper. The values recorded, viz. from 920 to 1,260 lb. per sq. in., are lower than those given for Burma teak (see tables below).

For comparison with the results of these tests on Nigerian teak the following figures for oak and Burma teak may be given. The figures for Burma teak are taken from the *Indian Forest Bulletin, No.* 14 (1913), "A further note on the relative strength of Natural and Plantation-grown Teak in Burma," by R. S. Pearson.

	Nigerian Teak. Variation. *Tons per sq. in.*	Nigerian Teak. Average. *Tons per sq. in.*	Oak. Average. *Tons per sq. in.*
Transverse tests	4·11 to 5·38 [1]	5·01 [1]	5·35
Compression tests	2·20 to 3·21 [2]	2·79 [2]	4·46
Shearing tests	0·411 to 0·563	0·504	—

	Natural-grown Burma Teak. Variation. *Tons per sq. in.*	Natural-grown Burma Teak. Average. *Tons per sq. in.*	Plantation-grown Burma Teak. Variation. *Tons per sq. in.*	Plantation-grown Burma Teak. Average. *Tons per sq. in.*
Transverse tests:				
1. Plains-grown teak	6·43 to 8·68	7·21	6·34 to 8·24	7·16
2. Hill-grown teak	5·90 to 7·99	7·20	5·17 to 9·70	7·54
Compression tests [3]:				
1. Plains-grown teak	2·45 to 3·22	2·89	2·20 to 3·05	2·69
2. Hill-grown teak	2·19 to 3·30	2·85	2·47 to 3·76	3·15
Shearing tests:				
1. Plains-grown teak	0·505 to 0·937	0·718	0·562 to 0·720	0·626
2. Hill-grown teak	0·625 to 0·885	0·736	0·505 to 0·797	0·672

[1] *The two lowest results have been rejected.*
[2] *The three lowest results have been rejected.*
[3] *Size of test pieces,* 2 × 2 × 4 *in.*

It is evident from these figures that the specimens of Nigerian teak dealt with in this report are inferior to Burma teak in transverse strength, but about equal to the latter wood in their resistance to compression. It must be remembered, however, that this sample from Nigeria is from a single comparatively young tree, and that it will be necessary to test a number of specimens of the wood from Nigeria before any trustworthy average figures can be obtained for comparison.

Mashuna Wood from Rhodesia

A sample of mashuna wood from Rhodesia was received in October 1907. It was stated in the letter accompanying the sample that the wood has been used to some extent by local waggon-makers and in mining, and that it is impervious to the attacks of white ants. No information was supplied as to the botanical source of the wood.

The specimen consisted of a log 4½ ft. long, 5 in. wide, and 4 in. thick.

It is a very hard, heavy wood of golden yellow colour, which darkens considerably on exposure to the air. It much resembles English elm in structure and figure.

Unlike most exotic hard woods of coarse grain it turns and planes moderately well without splitting or warping. It makes beautiful turned objects, the colour and the prettily marked grain showing up well on curved surfaces. It is, however, very fissile, and therefore somewhat troublesome to smooth both in planing and turning. For the same reason it does not take nails well. It takes glue fairly well, and is a good firewood.

The transverse strength of this timber is very great, being but little inferior to that of ash; it breaks with a long, fibrous fracture. The weight per cubic foot is 63½ lb.

This timber should be very useful locally for waggon building, house frames, and for other purposes where it can be used in large pieces and where strength is desirable. It would be of little use in thin boards, as these would split very easily.

It is unlikely that mashuna wood could be exported

profitably, as the cost of freight on such a heavy timber would prevent it competing successfully with other woods of equal merit which are already in possession of the market.

"Mukokoto" or "Mutumbwi" Timber (*Pterygota* sp.) from Uganda

The specimen of timber which is the subject of this report was forwarded for examination to the Imperial Institute in June 1912.

Herbarium specimens of the tree which were forwarded to Kew by the Chief Forestry Officer have been identified as a species (probably undescribed) of *Pterygota*.

The timber was submitted for examination to a technical expert, who furnished the following report:

In general appearance this wood is much like the commoner varieties of Ficus timber, being of a brownish-white colour, stained with blue throughout and in parts flecked with black. The wood is irregular in grain, and splits in a brittle manner like elm, although it is not so hard as the latter. It saws easily, but tears badly in planing.

The wood burns readily, leaving very little ash. It belongs to a class of timber commonly used in the tropics for packing-cases, and takes nails easily. The weight per cubic foot is 38 lb.

This mukokoto wood has no decorative qualities, and it could not be profitably shipped to Europe as timber.

"Duka" (*Tapirira* sp.) Wood from British Guiana

In connection with an enquiry as to the suitability of certain British Guiana timbers as substitutes for red cedar in the manufacture of cigar boxes, specimens of duka wood were forwarded to the Imperial Institute in July 1910.

According to a report furnished by the Forestry officer, British Guiana, to the Imperial Institute, duka is a species of *Tapirira*, allied to *T. guianensis*, Aubl. The tree occurs scattered singly in the forests of certain parts of the Colony, on the flat lands of sand and clay border-

ing the rivers and creeks, which are periodically inundated, and on slightly elevated lands or low hills of white sand. It is estimated that at such places where duka trees occur in the North West, Pomeroon and Demerara River Districts, the average number varies from one to three per acre, of an average girth of about 33 in., the largest tree measured being 63 in. in girth, but it is pointed out that probably not more than 50 per cent. of the trees are large enough for cutting. Large quantities of the wood therefore do not appear to be available. On the slightly elevated lands and low hills, the cost of transportation would prohibit the exploitation of the timber, unless it was cut along with woods of known commercial value such as "wallaba" (*Eperua* spp.), with which it is usually found associated in such situations. On the low-lying, swampy lands, however, where transportation is easier and cheaper, a limited quantity could be obtained. Two or three varieties of duka are stated to occur. According to the Hon. A. G. Bell (*On the Collection of Colony Woods at Plantation Christianburg*, Georgetown, Demerara, 1906), the wood can be obtained in logs up to 40 ft. in length, and squaring up to 17 in.

The samples received at the Imperial Institute consisted of three small planks of wood measuring 3 ft. by 9 in. by 1 in. The colour was pale dull red, somewhat resembling that of West African cedar, to which the wood was also similar in grain. The wood possessed a slight odour, which was not at all like that of cedar.

The wood was submitted in the first instance to cigar-box manufacturers for trial. An important company who manufacture and use a large quantity of cigar boxes reported that they considered the wood to be quite suitable for making a "second quality" of cigar boxes provided that the price was acceptable. They added that this duka wood had not the scent of cedar, but was otherwise not objectionable.

Another firm stated after an exhaustive trial of the wood that it was not suitable for the manufacture of cigar boxes for their purposes. They suggested, however, that the wood could be utilised in many other ways, if classed

as a hardwood and shipped in fair-sized planks at a reasonable price.

In order to confirm this last opinion a specimen of the wood was submitted to a firm of timber brokers, who stated that the wood is not known on the London market, and that the quality is not attractive, but that it might possibly find a sale in boards or planks as a substitute for mahogany. The price would, however, be low, say about *2s. 6d.* per foot cube. The firm added that if a small trial shipment of the wood could be forwarded it would be possible to furnish a more detailed report as to its commercial possibilities.

PARA RUBBER FROM THE GOLD COAST

THE cultivation of *Hevea brasiliensis* has been undertaken very successfully in the Gold Coast at the Government Agricultural Stations, notably at Aburi and Tarquah, and in addition European planters have established a number of plantations, some of which have now reached the productive stage. The natives in many parts of the country are also devoting attention to the cultivation of the tree. The climatic and other conditions in the Gold Coast appear to be well suited to the growth of the tree, and tapping experiments carried out at the Agricultural Stations at Aburi and Tarquah have given good results (see this BULLETIN, 1912, **10**, 316; 1913, **11**, 161).

In 1912 two blocks of trees at Aburi were tapped (*Rep. Agric. Dept., Gold Coast*, 1912, p. 30). In each case the renewed bark was tapped on one-third of the circumference of each tree, in one case on the vertical-parallel system and in the other on the half-spiral system. The average yield of dry rubber per tree in the first block for 158 tappings spread over the whole year was 2 lb. 10½ oz., and in the second block 2 lb. 13 oz. for 156 tappings. These results show an increase of fully ½ lb. per tree as compared with the yields obtained in 1911.

At Tarquah thirty experimental trees, eight years old, with an average girth of 33·13 in., gave an average yield of 3 lb. 12 oz. of dry rubber per tree when tapped on alternate

days throughout the year. This also is an improvement on the results obtained in the previous year. At the same station 1,000 trees were tapped on alternate days for twelve months, the average yield of dry rubber per tree being 2 lb. 3 oz. as compared with 1½ lb. in 1911.

In all, 2,808 lb. of rubber obtained during tapping experiments in the Gold Coast were sold on the London market during 1912. The sheet and biscuit rubber realised an average price of over 4*s.* 3*d.* per lb., and the scrap rubber 2*s.* 11*d.* per lb., which were about the average market prices for plantation rubber.

A sample of smoked Para biscuits from trees thirteen years old growing at Aburi was received at the Imperial Institute in January 1914. The rubber was stated to have been prepared by the addition of acetic acid in the usual way and then dried in a smoke-chamber.

The biscuits were thin and brown in colour, possessing a strong smoky odour. The rubber was clean and well-prepared, and its physical properties were very satisfactory. It was examined chemically with the following results:

	Per cent.
Loss on washing (moisture and impurities)	0·8
Composition of dry, washed rubber:	
Caoutchouc	94·1
Resin	2·9
Protein	2·7
Ash	0·3

This rubber was of a very satisfactory quality, comparing favourably in composition with the best plantation Para rubber from the East. Consignments of similar rubber would always find a ready sale at the current market price. At the date of the report it was worth about 2*s.* 1*d.* per lb. (July 1914).

PARA RUBBER FROM SIERRA LEONE

In Sierra Leone the plantations of Hevea are at present on the experimental scale, and are worked under the supervision of the local Forest Administration. Two samples of Para rubber produced experimentally in Sierra Leone

were received at the Imperial Institute in October 1913. The results of their examination are given below.

No. 1. *Trees Six Years old; coagulated with Lime Juice and dried in Smoke.*—Small, irregular biscuits of rough appearance and almost black in colour. The rubber was rather weak, and broke fairly easily when stretched. It gave the following results on analysis:

	Per cent.
Loss on washing (moisture and impurities)	1·4
Composition of dry, washed rubber:	
Caoutchouc	94·0
Resin	2·6
Protein	2·8
Ash	0·6

This sample was possibly worth 1*s.* 9*d.* per lb. in London, with fine plantation biscuits at 2*s.* 2*d.* to 2*s.* 3½*d.* per lb., and fine hard Para at 3*s.* 1*d.* per lb.

The rubber was of very satisfactory composition, comparing favourably in this respect with plantation Para rubber from the East; it was, however, of indifferent appearance, and rather deficient in elasticity and tenacity. Possibly the method of coagulation employed may have adversely affected the physical properties of the rubber, and it was suggested that it would be advisable to use acetic acid instead of lime juice for the purpose.

No. 2. *Trees Four to Five Years old; coagulated by Evaporation, dried in Air, and finally smoked.*—A few small biscuits of rubber and a small ball of scrap. The biscuits were pale brown, clean, and well prepared. The rubber exhibited fairly good physical properties, being much superior to sample No. 1 in this respect.

The biscuits were submitted to chemical analysis with the following results:

	Per cent.
Loss on washing (moisture and impurities)	1·0
Composition of dry, washed rubber:	
Caoutchouc	92·6
Resin	3·9
Protein	3·0
Ash	0·5

Biscuits similar to this sample would probably realise about 2*s.* per lb. in London, with fine plantation biscuits and fine hard Para at the prices quoted above.

This rubber was not quite so good as No. 1 in composition, but was much superior in appearance and physical properties. The latex should, however, be coagulated by the addition of acetic acid instead of by evaporation, as the latter method usually tends to increase the amounts of resin and protein in the rubber.

FUNTUMIA RUBBER FROM THE GOLD COAST

In previous numbers of this Bulletin (1907, **5**, 250; 1910, **8**, 261; 1912, **10**, 384) accounts have been given of the results of examination at the Imperial Institute of samples of Funtumia rubber from the Gold Coast, prepared by coagulating the latex in various ways. In January of this year a further sample, prepared by the addition of 1 per cent. of formalin to the crude latex, and then dried in a smoking-chamber, was received. The latex was obtained from trees about nine years old, growing at Aburi.

The sample consisted of thin, irregular biscuits, varying in colour from light to dark brown, and having a strong smoky odour; some of the biscuits were rather rough in appearance. The rubber was clean, and its physical properties were very good. It was analysed with the following results:

	Per cent.
Loss on washing (moisture and impurities)	3·1
Composition of dry, washed rubber:	
Caoutchouc	81·7
Resin	10·1
Protein	7·5
Ash	0·7

This rubber contained rather high percentages of resin and protein, which reduce the amount of caoutchouc to 81·7 per cent. The physical properties of the rubber were, however, very good, and consignments of similar rubber would probably realise 1*s.* 10*d.* or 1*s.* 11*d.* per lb. in London at the date of the report (July 1914).

CEARA RUBBER FROM PAPUA

Two samples of Ceara rubber, stated to be the first prepared in Papua, were received at the Imperial Institute

in February 1914. The rubber was obtained from trees two to two and a half years old, growing on an estate on the Baubauguina River in the East-Central Division, and planted 11 ft. by 11 ft. The soil is a sandy loam, and the rainfall fairly heavy, averaging about 100 in. per annum.

The samples were as follows:

No. 1. *Sheet Rubber.*—This consisted of two sheets of pale brown rubber, $\frac{1}{16}$ in. in thickness, and measuring 15 in. by 10 in. and 18 in. by 11 in. respectively. The rubber was clean and well prepared, and its physical properties were satisfactory. It was analysed with the following results:

	Per cent.
Loss on washing (moisture and impurities)	1·4
Composition of dry, washed rubber:	
Caoutchouc	88·5
Resin	4·7
Protein	5·7
Ash	1·1

The results of the examination show that this rubber was of satisfactory composition, and there is no doubt that consignments of similar quality would be readily saleable. Its value at the date of the report was about 2*s.* per lb. (July 1914).

No. 2. *Scrap Rubber.*—This consisted of a block of aggregated shreds of brown rubber, with a somewhat mouldy smell. The rubber was slightly "tacky" in parts. It gave the following results on analysis:

	Per cent.
Loss on washing (moisture and impurities)	9·4
Composition of dry, washed rubber:	
Caoutchouc	82·3
Resin	3·2
Protein	11·5
Ash	3·0

This scrap rubber would not realise such a good price as the biscuits, and at the date of the report it was probably worth about 1*s.* 8*d.* per lb. in London (July 1914).

It will be seen from the analyses that, as usual, the scrap rubber contained a much higher percentage of protein than the biscuits.

SPECIAL ARTICLES

THIRD INTERNATIONAL CONGRESS OF TROPICAL AGRICULTURE, LONDON, 1914

The Third International Congress of Tropical Agriculture opened at the Imperial Institute on Tuesday, June 23, and met daily, except on Saturday and Sunday, until Tuesday, June 30. A preliminary notice of the Congress and a provisional programme were published in this Bulletin (1914, **12**, 79). The following is the President's opening address delivered at the Imperial Institute on Tuesday, June 23.

OPENING ADDRESS BY THE PRESIDENT,

Professor Wyndham R. Dunstan, C.M.G., M.A., LL.D., F.R.S.,

Director of the Imperial Institute

The International Congress of Tropical Agriculture, which we meet to open to-day, is the third which has been held under the auspices of the International Association for Tropical Agriculture, the first having taken place in Paris in 1905 and the second in Brussels in 1910. At the close of the Brussels Congress the members of the Association did me the honour to elect me as President of the Association in succession to the veteran M. de Lanessan, who, as Governor-General of Indo-China, and afterwards as Minister responsible for the French Colonies in the Government of the Republic, did so much, through his intimate knowledge of the scientific problems of tropical agriculture, to promote its advancement in the French tropics. Fortunately we have continued to enjoy the advantage of M. de Lanessan's advice and assistance in the affairs of the Association which owes so much to his guidance. We all regret that continued ill-health prevents us from welcoming him, the *doyen* of the Association, among us to-day.

I accepted with considerable diffidence the honour so generously pressed on me by my Continental colleagues,

as among the many responsibilities it involved was that of carrying out the unanimous wish of the members of the Association that the next International Congress should be held in London.

Whatever success the present Congress may achieve is due to the co-operation in the work of organisation of the few members of the British Committee who are resident in London, and above all to the unremitting labours of the Honorary Organising Secretaries, Dr. Henry and Mr. Harold Brown. It is satisfactory that as a result of a year's arduous work an assemblage of distinguished men of all nations and an embarrassing wealth of communications on every aspect of tropical agriculture are the salient features of the Third International Congress of Tropical Agriculture.

His Majesty the King has shown his interest in our proceedings, and has recognised their importance by graciously consenting to become Patron of the London Congress. We have among the Honorary Vice-Presidents the Ambassadors in London of the Powers concerned in tropical agriculture, His Majesty's Principal Secretaries of State, the Viceroy of India, and other distinguished men who are or who have been connected with administration in the tropics.

The idea of co-operation and interchange of opinion among those of different nationalities who are engaged in the same work and who are working for the same end is undoubtedly a valuable one, and its realisation has been productive of most useful results in several important instances, so much so indeed that International Congresses of all kinds, great and small, on all sorts of subjects have become very numerous in recent years. This is a significant development of the times which no one would desire to deprecate on general grounds. Yet from their great number the danger now is that the importance of those which deal with subjects of great public moment is apt to be overlooked.

There is no subject at the present time in the whole field of human activity which demands greater attention than the organisation of those agencies which make for

the agricultural productivity of the tropical regions of the world. The subject is of importance to the native races of the tropics who are coming more and more under European control and influence, and who look to European knowledge and experience for guidance in increasing the productivity of the soil.

It is of no less importance to all Governments of tropical countries, which are principally concerned in securing under good governance their material and commercial advancement.

Moreover, the temperate world has to depend on the tropics for the supply of numerous materials which have become necessaries of life and the basis of some of the most important manufacturing industries of modern times.

A Congress which meets to consider and discuss the problems of tropical agriculture in their widest bearings is therefore of the highest importance to all civilised nations. It has been our endeavour to make this, the Third International Congress of Tropical Agriculture, which meets for the first time in the principal city of the British Empire, a thoroughly representative and successful one, of value not only to this country and to the Empire whose tropical interests are so extensive, but also to those other nations whose representatives we welcome here to-day.

I should like very briefly to indicate the principal objects which the British Committee have kept in view in organising the present Congress. The topics of first importance to the advancement of tropical agriculture have been given a prominent place in the proceedings of the Congress. Education, research, legislative enactments relating to plant diseases, tropical sanitation and hygiene, credit banks and co-operative societies are to be considered at meetings of the Congress, as are also such important problems of general interest at the present time as the improvement of cotton cultivation, the fertility of soils in the tropics, the production of fibres, and the preparation of plantation rubber. Sectional meetings will be devoted to the discussion of papers on each

important group of agricultural products, where also technical questions connected with soils and manures will be considered.

Special papers on several subjects of general interest will also be given.

The advancement of tropical agriculture must chiefly depend on the labours of the specialist, the practical agriculturist and the investigator, whose contributions form the groundwork of our Congress. It is, however, important that the directions of advance, the nature of the problems to be solved, and the methods which have to be followed in solving them, should be generally understood, and their great importance appreciated by two other classes in the community: by administrators and officials of Governments, and by manufacturers, merchants, and other users of the agricultural products of the tropics.

The advance of tropical agriculture by scientific methods needs the interest and support of those who have the duty and responsibility of administering the Governments of tropical countries, as well as of the users of the raw materials, the representatives of the great manufacturing industries. For this reason the assistance in the work of the Congress has been secured of a number of distinguished Government representatives, and also of manufacturers, companies, and firms who make use of tropical agricultural products.

The list of Honorary Vice-Presidents will show that we have enlisted the interest and support for the Congress of a large number of distinguished Government representatives responsible for administration in the tropics.

It has been the endeavour to bring together scientific and practical authorities on tropical agriculture, and representatives of the great tropical planting industries, representatives of the Governments of tropical countries, and representatives of the industrial and mercantile community concerned in the utilisation of tropical agricultural products. In this I think we may claim to have been highly successful. We have a large attendance of tropical agriculturists, scientific and practical, from nearly if not

every country concerned. The number of papers on technical subjects exceeds 200, including within their scope almost every aspect of tropical agriculture. It will not be possible indeed within the week which is assigned to the Congress to get through our work unless we can depend on the co-operation of the many authors who are present in person, and on those who take part in the discussions in observing the utmost brevity in addressing the meetings, by confining themselves to essential points, and remembering that papers will be printed in the *Transactions* of the Congress.

As it is also hoped to print the principal contributions to the discussions, those who take part in them are requested to assist our work by sending to the Secretaries after the meetings succinct written reports of their remarks.

It has been decided to consider a selection of subjects of general importance at General Meetings of the Congress, and at certain of these meetings it has been arranged for the chair to be occupied by well-known representatives of Governments or of industries, to whom the advancement of tropical agriculture is of vital importance. The improvement of cotton cultivation is to be considered at a General Meeting on June 29, when I am happy to announce that Lord Kitchener, one of our Honorary Vice-Presidents, will take the chair. Lord Kitchener represents a country in which agriculture is the chief industry, and he has shown the greatest interest in its advancement, and that of the great cotton-growing industry in Egypt. Following a discussion of problems connected with the preparation and quality of plantation rubber a series of important papers on rubber will be read at a meeting on June 25, at which Sir Edward Rosling, formerly Member of the Legislative Council and Chairman of the Planters' Association of Ceylon, will be in the chair. Questions connected with the cultivation of wheat and other cereals will be discussed at a meeting on the same day, at which Sir Louis Dane, lately Lieutenant-Governor of the Punjab, will take the chair. Co-operative Credit Societies and Banks will form the subject of another meeting, at which

Sir Horace Plunkett will take the chair. Sir Ronald Ross will preside at a discussion on Sanitation and Hygiene on Tropical Estates.

The Congress is especially indebted to the Secretary of State for the Colonies, one of our Honorary Vice-Presidents, who is to preside at a meeting at which the cultivation of cotton is to be discussed. Mr. Harcourt has shown great personal interest and has rendered valuable assistance in the organisation of this Congress.

Sectional meetings will be held to discuss papers on cotton, rubber, cocoa, tobacco, and fibres. At the meeting at which cocoa is to be considered the chair will be taken by Sir Hugh Clifford, the Governor of the Gold Coast, where cocoa cultivation has made enormous strides in recent years. At the meeting at which papers on Jute and Hemp Fibres will be read, Mr. C. C. McLeod, Chairman of the London Jute Association, will take the chair.

A special paper will be read on the Work of the British Cotton Growing Association by the Chairman, Mr. J. Arthur Hutton, at which Lord Derby, the President of the Association, will take the chair. Lord Emmott, Under-Secretary of State for the Colonies and a member of a firm of cotton spinners, will be among the speakers. Other special papers are on the Fibre Industry of British East Africa, by Mr. Alfred Wigglesworth; on the Utilisation of Sun Power for Irrigation and other Purposes in Tropical Agriculture, by Mr. Frank Shuman; and on the Karakul Sheep, by Prof. Wallace.

In order to get through our work it will be necessary to meet in the afternoons as well as in the mornings, and to commence the proceedings as a rule at 10.30 in the morning, with an interval of about an hour in the middle of the day, and of half an hour in the afternoon, the work of the meetings terminating at 6 p.m.

Some Recent Advances in Tropical Agriculture

In the four years which have elapsed since the last International Congress met in Brussels many important developments in tropical agriculture have taken place which will form the subject of papers and discussion at

our meetings, and to which I shall be able only very briefly to allude in this address.

An immense impetus has been given to the cultivation of rubber, chiefly through the largely increased demand which has arisen for rubber tyres owing to the perfection and general use of motor vehicles. The increased demand occurred at a time when but few of the larger rubber plantations in the East had come into full bearing. A rapid and unprecedented rise in the market price of the raw material took place, and as a result new plantations were initiated in every country, especially in Asia and Africa, in which rubber can be grown, as well as in some places where the chances of success were very small. During this period rubber trees of every description were grown in plantations on a large scale, of which Hevea, Ceara, and Castilloa are the most important. A struggle has since been in progress from which we are now beginning to emerge. There has been not only competition between the rubber of these plantations and the rubber derived from the forests of South and Central America and Africa, the result of which mainly turns on cost of production, but there has also been competition between the rubber of plantations of Hevea, of Ceara, and of Castilloa, the result of which turns not only on cost of production, but also on the yield and quality of the crude rubbers furnished by these different trees. Certain conclusions are already definitely indicated. One is that the high reputation of the Hevea tree as a rubber producer in countries in which natural conditions are favourable to its growth is established beyond all question. Ceara and Castilloa trees, however, undoubtedly have possibilities in other countries, the climate and soil of which are unsuitable for *Hevea brasiliensis*. The production of rubber from Castilloa trees in plantations is confronted with special problems which are to be discussed at one of our meetings.

It is, moreover, established that under existing conditions rubber from Hevea plantations can be produced at a smaller cost than the same rubber collected from forest trees in the Amazon region of South America.

Two questions remain. One is as to the maintenance of an ample supply of cheap labour for the plantations of the Eastern tropics; the other, with which we are more immediately concerned, is as to the quality of the rubber produced in plantations as compared with that of the rubber obtained from the trees of the forests of South America. The latter question is to form the subject of a special discussion at one of the meetings of the Congress, at which it is hoped that, as the result of an interchange of views between specialists, planters, and manufacturers, some further light may be thrown on this important question. I need not now do more than remark that the evidence that plantation rubber obtained by satisfactory methods from well-established trees and properly prepared is equal in quality to that of forest trees is too strong to be doubted. We have yet to learn the precise cause of variations which it is alleged are sometimes shown by plantation rubber, and which are said to interfere with its uses for some manufacturing purposes.

Before leaving the subject of rubber production I ought to allude to the artificial production of this material by chemical means, which has now been satisfactorily accomplished by laboratory methods. It has still to be proved that these laboratory methods can be successfully translated into operations on a large scale, so as to produce commercially rubber of high quality, and cheaply enough to compete with natural rubber. The improvement of plantation rubber and the cheapening of its cost are the main problems for the rubber grower. The possible success of synthetic rubber is generally regarded as the bogy of the rubber industry, and the success of synthetic indigo is often quoted as an ominous precedent. It is indeed an important precedent, but in a different sense. The indigo planter did not realise, until it was too late, the fact that improvements in methods of production and cheapening of cost were the vital problems, and that the best hope for the future of the industry lay in the direction of systematic and continuous investigation with a view to the solution of these questions. While these very problems in connection with the production of

synthetic indigo were engaging the close attention of investigators in Germany, little or nothing was being done by planters to improve the natural production. The moral is obvious, and is, I think, fully realised by leading rubber planters. Already important improvements in production have been carried out, and the cost of production has now been so considerably reduced on many estates that the commercial success of synthetic rubber seems a highly improbable contingency.

In all industries risks have, of course, to be taken, and there are some against which no human foresight can provide. It has more than once been suggested that it is by no means without the range of possibility that tyres might be constructed on a different principle, involving the use of metal with little or even no rubber. The way to minimise this risk is to extend the industrial uses to which rubber is applied, and definite steps are, it is understood, now being taken to this end.

I have made this brief allusion to the rubber problems of to-day because they point to a condition of affairs which, so long as it is allowed to continue, is a serious menace to the proper progress of tropical agriculture. The extraordinary development of the rubber-growing industry has, from the scientific standpoint, taken us unawares. A large and rapidly increasing industry was suddenly confronted with a number of questions which no one could properly answer, for the good reason that the necessary knowledge did not exist. The exact origin, nature, and functions in the tree of the latex which carries the rubber were not known, and are not precisely known even to-day. These problems belong mainly to the regions of botanical physiology and of chemistry, but had been little investigated. They lie at the root of the many practical questions which arise in connection with the production and flow of latex, the relation of latex production to the nutrition of the tree, and the methods of securing a steady production of latex without undue interference with the vitality and growth of the tree. Little was known as to the effect on the tree of the continuous removal of latex or of the relative effect of different methods

of tapping. The consequence was that these investigations have had to be carried out while the plantations waited for the knowledge, which has now been largely gained in part through observations and experiments made by practical planters.

The number of trained investigators in the tropics has been so small that there are large gaps in our knowledge which can only be slowly filled. The entire subject of the science of growing rubber trees in plantations should receive continuous investigation by trained specialists. The fungoid diseases to which the rubber trees are subject, and the insect attacks to which they are exposed, are no less important to the rubber grower than those which relate to the life-history of the plant, its physiology, and nutrition. It must be admitted that the scientific means of defence had not been prepared, and that we were not ready for action at a moment of weakness. To this general question of technical education and research, which is to be considered at more than one of our meetings, I shall return in another part of this address.

Another subject which will claim much of our attention at this Congress is the large and important one of cotton growing and its improvement. Lord Kitchener is to preside at one of several meetings on this question, when cultivation in Egypt will be considered, and at another Mr. J. Arthur Hutton, the Chairman of the British Cotton Growing Association, will give an account of the great work which that Association has done in the last twelve years to extend and improve the cultivation of cotton within the British Empire, and to open up new fields of supply for the mills of Lancashire. Herr Schanz in another paper will describe the advances in cotton cultivation in the German Colonies. Again we are confronted with problems which need for their solution continuous scientific investigation and systematic experiment, and here again adequate means of research were not available in the first instance, and in some cases are not completely provided now. The discovery of a kind of cotton capable of being acclimatised in a new country, and possessing the characters which will render its production profitable, is one which requires

time for its solution. In addition to the well-known process of seed selection, the newer methods of plant breeding require to be tried in a well-considered scheme of work in which both practical agriculturists and trained specialists can act in co-operation. Some notable advances have been made, especially in India, in Nyasaland, Uganda, in French West Africa, and in German East Africa, but the fact cannot be too strongly emphasised that what is needed is continuous effort and experimental work in each country in which cotton cultivation promises success.

Whilst we in this country are naturally concerned in the first instance to improve and increase cotton cultivation within the British Empire, it is to the advantage of all nations that the world's supply of good cotton should be increased. It is of importance, therefore, that those engaged in this work in different parts of the world should occasionally meet together to compare notes and exchange views, and for this reason the value of an International Congress such as this cannot be over-estimated.

In this country at the present time we are specially and financially interested in a large attempt, chiefly due to the initiative of Lord Kitchener, which is about to be made to grow Egyptian cotton under irrigation in the Gezira district of the Anglo-Egyptian Sudan, an enterprise which will require not only sound, practical management, but also careful experiment, close supervision, and cautious advance under the advice of specialists in cotton cultivation.

I think I may safely say that Lancashire spinners, while greatly interested in this enterprise, would view with satisfaction a similar development on the opposite shore of the Mediterranean. Asia Minor, which I visited a few years ago, appeared to me to offer a promising and very large field for the growth of long-stapled American Upland cotton of a type which is in great demand not only in Lancashire, but also throughout the Continent of Europe.

With the advent of irrigation in Mesopotamia additional possibilities for cotton growing in Asia Minor are opened up. With the development for cotton growing in these

great tracts, in Egypt, the Sudan, and in Asia Minor the demands of Europe for two of the principal grades of cotton would in a very large measure be met, and the principal manufacturing requirements of the Old World largely derived from within its confines.

In this connection importance must also be attached to the advances which are being made in improving and extending cotton cultivation in India, which are to form the subject of communications to the Congress.

The dividing line between forestry and agriculture is not easy to draw, especially when we attempt to classify agricultural and forest products. There has been in the last few years an important advance in a subject which lies at present, perhaps, within the domain of forestry, since the materials are largely obtained from naturally occurring trees in the forests. I refer to the oil-yielding trees, especially those which furnish oils suitable for the manufacture of soap or for other purposes. Oils which are edible are now in large demand for the manufacture of those preparations now so widely used in cooking, which under various names are partly or wholly composed of vegetable oils or fats. The result of the demand for certain oils for edible purposes which were formerly used for soap-making has led not only to a rise in the price of these materials, but to a demand on the part of the soap-maker for the supply of other and cheaper oils suitable for his purpose. The oils now in demand include cotton seed, arachis (ground nut), sesame, and some others, which may be regarded as agricultural products, as the plants are grown as crops in the field. Coconut oil, palm oil, and palm-kernel oil are three of the most important of vegetable oils used for soap-making, and more recently for edible purposes. Coconuts have passed into the domain of agriculture, being now cultivated in plantations. The proper cultivation of these palms is a subject of great importance which requires serious attention. The habit, nature of growth, and of nutrition in relation to productivity require study from the plant physiologist; the diseases, fungoid and insect, to which the coconut palm is subject, and the treatment of the soil and manuring

of plantations, are matters in which our knowledge is fragmentary and incomplete, and which should receive attention, in view of the great commercial importance of this crop. The West African oil palm is another most important source of two oils respectively derived from the pericarp of the fruits of this palm and from the kernels of the seeds. The oil or fat furnished by the pericarp, and roughly extracted by native methods, was, not many years ago, familiar as the orange-coloured lubricating grease employed on railways. At a later period a demand at an increased price arose for its use in connection with soap manufacture. More recently attention has been turned to improvements in extracting and preparing palm oil, with the result that a material devoid of the objectionable colour and flavour of crude palm oil has been obtained which seems likely to be in demand at remunerative prices for edible purposes. The subject of the growth and treatment of the African oil palm is one which is beginning to demand serious study. This question of palm oil is to come before the Congress at one of the sectional meetings, when we shall have an opportunity of congratulating our French and German colleagues on their activities in improving the methods for its extraction, from which more than one British industry will gain.

Before I leave this brief reference to some of the more important advances which have occurred since the Congress met in Brussels, I must refer to a remarkable change which has taken place with reference to the production of cocoa, the principal centre of which is now the British Colony of the Gold Coast. There was an output of 11,407,608 lb. in 1905, when the Congress met in Brussels. It had risen to 45,277,606 lb. in 1910, and last year (1913) it was 113,239,980 lb., and therefore this country now stands first on the list of cocoa-producing countries. This remarkable result is not merely due to labour difficulties in other cocoa-producing countries; in fact, the Gold Coast is not free from these difficulties itself. It is mainly due to the fact that the climate of the Gold Coast over a large area has proved to be particularly well adapted to the growth of cocoa, whilst the native farmers, with advice and assistance

from the local Department of Agriculture, have taken up the subject with great energy and success.

The cocoa industry of the Gold Coast is in fact a notable example of an enterprise which has been brought to success as a native industry aided, and to some extent supervised, by Government, but without pressure or coercion in any form.

A paper on the subject by the Director of the Agricultural Department of the Gold Coast is to be read at one of the sectional meetings of the Congress, when we shall have the advantage of the presence of Sir Hugh Clifford, the Governor of the Colony which looks, under his guidance, to other developments in agriculture, in which he is known to take so great an interest.

If, in concluding this review, I refer to tobacco and sugar, it is only to draw attention to a community of interests in temperate and tropical agriculture, which it was another object of the organisers of this Congress to foster. We are glad to welcome on our General Committee and at our meetings a number of distinguished representatives of agriculture in this country. Tobacco is one of several crops which have taken their place in temperate as well as in tropical regions. It has, of course, been known for long that the tobacco plant could be grown in sub-tropical and temperate regions, but recent developments indicate that certain kinds of tobacco may not only be grown, but successfully cured of satisfactory quality in a number of new areas, among which may be mentioned Canada, South Africa, including Rhodesia, and Ireland, whilst promising trials are being made in this country. The subject is one which needs increased attention in the tropics, especially in relation to the growth of cigar tobacco.

In the short period under review great strides have been made in the region of tropical medicine and hygiene. Our knowledge of several important tropical diseases is now sufficiently complete to enable remedial and preventive measures to be taken with so great a success that, provided certain precautions are taken, life in the tropics is deprived of many of its dangers.

The Imperial Institute a Centre for Information

As we are assembled for our Congress in the Imperial Institute, I may draw attention to the necessity for a sort of Central Clearing House for collecting and supplying trustworthy information on all subjects connected with tropical agriculture, and especially with their technical and commercial aspects. The Imperial Institute during recent years has been identified with investigations and reports chiefly as to the value for technical and commercial purposes of tropical agricultural products of all kinds. A large staff of men who have specialised in these products and their uses are at work in the laboratories of the Scientific and Technical Department.

The Institute is in communication with Agricultural Departments in India and the Colonies on all these subjects, as well as with manufacturers and users of tropical materials at home and abroad, for whose benefit classified sample rooms are maintained, and the important products of the British tropics exhibited in Public Galleries.

The Imperial Institute is also called upon to afford special information respecting every aspect of tropical agriculture and its products, which it is specially qualified to procure and supply through its communications, both with the countries concerned and with manufacturers. Much of the information thus collected hitherto has been published from time to time in the quarterly *Bulletin of the Imperial Institute*, and in special reports, also published. The work has, however, now grown to an extent which requires a separate organisation to cope with it, and this is now being arranged. It is to be known as the Technical Information Bureau, and it will serve as a centre from which trustworthy information with reference to the production and utilisation of tropical agricultural materials of all kinds will be issued, and the Bureau will from time to time publish reports for the benefit of the agriculturist in the tropics as well as of the manufacturer at home.

Technical Education in Tropical Agriculture

I desire now to pass to a subject of great importance to this Congress as vitally affecting both the status and the achievements of tropical agriculture. I refer to the provision of technical education for those who desire to make tropical agriculture the work of their lives. The subject is one which is claiming the consideration of all nations with interests in the tropics, and more especially of this country, whose tropical interests, direct and indirect, are greater than those of any other nation in the world.

In several countries steps have been taken to provide agricultural education for the natives. I do not propose to deal principally with this question, although reference to it is necessary as the subject is intimately connected with the point to which I desire to direct special attention, which is the technical education of Europeans who are called to fill responsible agricultural positions in the tropics, whether as teachers of natives, officers of Government Departments of Agriculture, or supervisors, managers, or assistants on tropical estates. At the present time the education of men who are to fill these important positions is not definitely provided for, but is left to chance. In order to confine myself within the limits of a Presidential Address in a matter of the first importance which is to receive special consideration in meetings of this Congress, I shall confine my remarks chiefly to this question in its relation to the tropical possessions of Great Britain, and in doing this I wish to emphasise its great national importance.

The agricultural development of British tropical countries has made remarkable strides during recent years. This progress is of especial interest, since it has been achieved in the main by the employment of British capital, several hundred millions sterling being now invested in agricultural undertakings in the tropics. It has, moreover, led to a largely increased output from British sources of some of the most important raw materials of industry and commerce, of which it is sufficient to mention only cotton

and other fibres, rubber, cocoa, and tea. As a consequence of British initiative, the natives of the countries concerned have profited through increased trade and general prosperity, and also through the great need which has arisen for the employment of labour on a large scale, under satisfactory conditions and at rates of remuneration which show a steady increase. The native labourer is now fairly remunerated, well treated, and well provided for in matters of food and general sanitation. The native capitalist has been given every facility to embark on agricultural operations on modern lines, and he owes much to the example and enterprise of the European planter, as well as to the assistance of the Government.

With this material progress has come, somewhat slowly, the recognition of the fact that tropical agriculture is an applied science, and the reflection that progress would have been more rapid and less costly had it been effected more generally under that enlightened direction which depends on the considered application of scientific principles.

Agriculture in Europe is now thoroughly alive to these important considerations, and agricultural education is everywhere regarded as an essential preliminary to agricultural practice. Tropical agriculture has, however, only just reached this position, and its progress so far has been in the main effected by men who have had to learn at their own cost, or at the cost of their employers, the intricacies of a subject in which only accumulated experience and native shrewdness were available as guides. The partial successes of the past afford, however, no reason for delaying an advance which has been made in all other professions, in which a system of technical education has replaced one of apprenticeship. The apprenticed apothecary of the past was successful in his own time, but he is now replaced by the scientifically educated and technically trained physician and surgeon, and no one would dream of reverting to a system of apprenticeship in place of the thoroughly equipped medical schools of to-day. The European farmer and employer of agricultural labour is now usually an educated man who has

passed through the curriculum of one of the many efficient agricultural colleges which exist in this country and, indeed, throughout Europe.

The time has come to consider how education in tropical agriculture can best be provided. The opening up of new countries such as East, West, and Central Africa by European enterprise in agriculture has greatly increased the demand for men who are properly qualified to undertake such pioneer work. At present the means of learning the essentials of tropical agriculture usually consist in undergoing, with or without previous knowledge of temperate agriculture, a system of apprenticeship, in which all the difficulties and disadvantages of this antiquated system of learning are apparent. In what is now known as the Middle East, in India, Ceylon, and Malaya, the young man new to the tropics, usually without any agricultural experience, is apprenticed as a "creeper," and learns the ordinary procedure of the estate whilst entrusted with more or less responsible duties of management and supervision. Many of the larger planting companies are beginning to recognise the inadequacy of this plan of providing for the supreme management of estates on which from time to time arise problems which no amount of accumulated experience and judgment are competent alone to resolve. As a result, men are now beginning to be selected as assistants who have previously passed through the course of an agricultural college at home, and who have only to learn the special methods and problems of tropical agriculture during their career as apprentices. This step in selecting partially educated men is a significant and satisfactory advance in the right direction. The men thus selected have received a training in those sciences, such as chemistry and botany, on which the practice of tropical, as of temperate, agriculture depends. They have also gained some knowledge of general agricultural procedure and of estate management, all of which is of distinct value. They are, however, wholly unacquainted with tropical conditions and problems, and know nothing of the existing practice as regards the cultivation of tropical crops, whilst they are wholly ignorant of even the

principles of the management of native labour and of the routine to be followed in the growth of tea, rubber, coffee and cocoa, and tropical foodstuffs. The problems and difficulties which confront them in these subjects are beyond their previous experience and training.

It has to be recognised that it is necessary before a man, even with a diploma in European agriculture, can take an effective part in the management of a tropical agricultural estate, or play any important part in improving agricultural methods and solving special problems, or in teaching agriculture to natives, to have been well trained and thoroughly well informed as to the fundamental facts and conditions of tropical agriculture, which differ widely from those met with in temperate agriculture.

I have referred to the state of affairs as regards the great estates and planting companies all over the British tropics. The position is even less satisfactory as regards the Europeans who go out as teachers in native schools and colleges in the tropics, who, if they have enjoyed the advantage of having studied in an agricultural college at home before proceeding to their duties in the tropics, which is not always the case, are placed in the false position of having to teach agriculture under conditions with which they are wholly unacquainted, and as to which the special knowledge required can, under the circumstances, only be gained whilst they are filling the position of teachers and not of learners. Added to this fundamental defect is that of unfamiliarity with tropical climate and conditions of life and with the mind of the native. After some years a few of these men acquire, under unsatisfactory conditions, the knowledge required, and make efficient teachers, but there is little to be urged in favour of such a haphazard method of dealing with the subject.

The case of Government officials in agricultural departments in the tropics is more serious and even less satisfactory, since men without any experience of the problems of tropical agriculture are often presented as authorities to the native agriculturists. The natives are often men of large knowledge and experience of tropical agricultural practice, which is the foundation from which the European

should work. A number of men, especially those with previous agricultural experience at home, have managed during their periods of office to acquire, sooner or later, the necessary fundamental knowledge, and to become efficient officers. This, however, is no excuse for not providing a proper education for such officers adapted to the purposes in view. Experiments and new departures in tropical agriculture cannot be properly made, or advice safely given to natives, unless the European officer is thoroughly acquainted with the fundamental facts and conditions of tropical practice.

An Imperial College of Tropical Agriculture

What is now urgently required is an agricultural college in the tropics to which men with the diploma of an agricultural college at home can proceed, to receive a technical education in the subject and thoroughly qualify themselves for the profession of tropical agriculture.

In India agricultural colleges have been founded in recent years, but the courses of instruction provided are chiefly designed to meet the needs of native students, and are not adapted to the purpose of the European student, who comes equipped with some knowledge of general agricultural principles. The same objection applies to the otherwise excellent Agricultural School at Giza in Egypt. In the Southern United States of America several agricultural colleges exist in which special courses are given in sub-tropical cultivation, and where the European student may gain important knowledge respecting the problems of cotton and maize, tobacco and sugar growing. These institutions, not being situated within the tropical zone, do not, however, afford all that special experience and knowledge of certain crops which are essential for the students whose needs are now being considered.

No one who has studied this question in its many aspects can doubt that great need exists for the establishment within the British tropics of at least one agricultural college, properly equipped with all the facilities for instruction and research in the several branches of tropical

agriculture. Nor can it be doubted that well-trained men with the diploma of such a college will readily find remunerative employment. Beyond the immediate requirements of the ordinary student such a college should become a most important centre of tropical agricultural research, not merely for its own advanced students, but for trained investigators of special subjects from all parts of the world, who would there find ample materials and opportunities for their researches.

The question, therefore, is how best to realise the conditions necessary for the establishment of such a college. To begin with, it is essential to provide a thoroughly well equipped central college which shall serve the needs of those countries for which at the present time there is the greatest demand for trained agriculturists. The tropical countries of the British Empire are, however, scattered, and differ much in their agricultural conditions and needs. It is therefore to be anticipated that the successful establishment of one college will be rapidly followed by others in different countries. It can hardly be questioned that, all things considered, the area now called the Middle East has the first and best claim to be the site of such an institution, and that Ceylon is the country best adapted for the purpose. Ceylon is already the centre of a large agricultural community, both native and European. Openings for well-trained men are numerous and well paid, whilst the general conditions of agricultural practice resemble those of the Straits Settlements and Malay States and Southern India, and also afford a satisfactory training-ground for the agriculturist in tropical Africa. Ceylon has a variety of climates, and offers illustrations of the growth of a variety of crops. In particular it is a great centre of agricultural production, and occupies a leading position in the tea and rubber production of the world. In addition to presenting a satisfactory climate and a healthy environment for young Europeans, it is within comparatively easy reach of home. It contains at Peradeniya tropical gardens with specimens of the most important tropical plants of the world, and is

now provided with a Government Agricultural Department, with a staff of botanical, chemical, and entomological experts who would be able to render important service to such a college as is proposed. Without in any way desiring to underrate the importance of establishing a similar college in the West Indies or in other parts of the tropics, there is, I think, general agreement that Ceylon is the colony best adapted in every respect for the establishment of the first College of Tropical Agriculture which will efficiently serve at least the needs of the whole of the Middle East and of Eastern and Central Africa.

The Government of Ceylon is understood to be favourable to the proposal, and the Secretary of State for the Colonies has declared his interest in and sympathy with the scheme. It is welcomed by the large companies whose estates cover so large a part of the island, and who are ready not only to offer paid positions to those who obtain the diploma of the college, but in addition are willing to assist in obtaining the funds required, which, it is estimated, will amount to about £50,000. It is hoped that the Government of Ceylon, as well as the Governments of other countries interested, will give financial assistance to a scheme which promises to have far-reaching consequences in promoting the prosperity of the British tropics, and is not to be regarded as of benefit only to the colony in which the college will be placed, but as serving an Imperial purpose. There is another important reason why the Governments of the Eastern British tropics should financially assist its establishment. In every British colony there exists, at all events, the rudiments of an Agricultural Department, more or less completely equipped for the purpose of conducting experimental work in agriculture for the benefit of the colony as a whole, and of affording assistance and advice to the resident agriculturist, native and European. It is obvious that if such a department is to be in a position to discharge these responsible duties its work must be directed by an officer who is a master of his subject, and who can discuss agricultural problems

with as much practical knowledge and experience as the average agriculturists of the country in which he is to occupy the position of chief agricultural adviser.

It is well known that men fully qualified to act as Directors of Government Agricultural Departments in the British tropics are very difficult and often impossible to secure. Apart from the usual difficulty in finding men who combine some administrative capacity with the requisite technical knowledge, the main trouble is that there is at present no systematic means of educating and training a tropical agriculturist, and the men who to-day occupy these positions are usually botanists or chemists who have trained themselves whilst in office. It is admitted that these men have often been able to render distinguished service, but it must now be recognised that the absence of any system of education under which such officers can be trained for their responsible duties is one which calls for immediate attention. The present difficulty which Governments find in filling such posts would be removed by the establishment of the College of Tropical Agriculture, since each year a number of thoroughly qualified men with the diploma of the college would be available to select from. There are, therefore, strong reasons why Governments should do everything to support, financially and otherwise, a scheme for providing technical education in tropical agriculture, destined to promote objects which it is to the interest of Governments to secure.

Apart from the contributions of Governments and of companies there is need for private benefaction, especially on the part of the many in this country who owe their wealth to their association with tropical agriculture. It is therefore desirable to give some details of the scheme which has been prepared by the London Committee for the establishment of an Imperial College of Tropical Agriculture.

It is proposed, if the proper arrangements can be secured, to place the College at Peradeniya, in Ceylon, in proximity to the famous gardens and also to the Government Agricultural Department. Here, at an ele-

vation of 1,600 ft. and in a healthy climate and fine surroundings, will stand the college buildings, with laboratories and lecture rooms. The courses of instruction will be supervised by the Principal. Instruction will be open to all those who produce the diploma of an agricultural college or other evidence of possessing the preliminary knowledge requisite for attendance at such special courses. As educated and otherwise properly qualified native students will be admitted, as well as European students, it is intended to erect in proximity to the college at least two residential hostels, one or more for Europeans, and others as required for native students, each in charge of a bursar.

In addition to the teaching given at the college, arrangements will be made for the students, in groups, to visit for short periods other agricultural centres in the island, and there study agricultural problems on large estates. The entire course of work will occupy a period of one year, which will be continuous, and would, therefore, be equivalent to about two years' work at a university or college at home in which actual residence, apart from vacations, does not much exceed six months in each year. In the ordinary sense there will be no vacation for European students in the college in the tropics, because no vacation is really needed under the conditions of life proposed, whilst the difficulties of providing for a satisfactory vacation in the ordinary sense within the island are considered to be insuperable. Suitable opportunity for recreation will be provided within the discipline of the college. Parents in England who wish their sons to take up tropical agriculture as a career will therefore be assured of a satisfactory supervision during the year of study in Ceylon. The cost of board, residence, and instruction for this year is estimated at £150, which, having regard to the longer period of the curriculum, is rather less than the cost of an agricultural college at home.

It is very desirable that scholarships should be offered of this value to students at agricultural colleges at home, in order to render easier the special training of the most

promising of those students who wish to take up tropical agriculture. Private benefaction might well assist the scheme by providing such scholarships.

It is to be hoped that it may be possible to provide in Ceylon for the realisation of the scheme. If not, Southern India offers many advantages, and there are some who desire to see the college founded in the Federated Malay States. In dealing with the question in detail, it is important that certain facts should be kept very clearly in view.

The college should be Imperial in its educational character, and open to properly qualified candidates from all parts of the Empire, without distinction of race.

The college will provide a training and experience in tropical agriculture for those who are already qualified in general agricultural principles and in the sciences connected with agriculture, as evidenced by the possession of the diploma of any recognised college or university.

The Imperial College, while having close relations with the Government Department of Agriculture in the country in which it is established, should, as an educational institution, be separately organised under the management of a Committee on which all agricultural interests are represented, with a representative governing body in London.

The college should not trench on the domain of local colleges and schools engaging in elementary teaching, but should be a place of advanced learning and research for those who have already received a general agricultural education.

In founding a college to fulfil such important purposes, so closely connected with agricultural advancement, it is hoped that the Governments of the tropical countries will participate, and, having regard to the great national interests affected, it may reasonably be hoped that the Government of this country will give the scheme, when complete, its financial support. The National Exchequer has responded not illiberally to demands for financial assistance for closely allied subjects, such as the advancement of tropical medicine, and it has assisted in the formation of an Imperial Bureau of Entomology.

Closely connected with, though distinct from, the establishment of such a college on satisfactory educational lines is the provision of suitable accommodation for European students, and of a proper discipline during their residence in the tropics. In the first instance, at all events, the large majority of the students will be young Europeans who will be new to life in the tropics, and who will need at least as much care, attention, and discipline as they receive in a college or university at home. The question of the erection of hostels or boarding-houses and their management is one for consideration apart from the establishment of the college. Whilst the duty of erecting and establishing the college is one which should devolve principally on the Governments of the countries concerned, and partly on the planting companies and firms interested, it seems desirable that the hostel for European students, though subject to the Board of Management of the college, should be endowed by separate European subscription.

The establishment of an Imperial College of Tropical Agriculture is to be considered at this Congress, and it is hoped that as a result further co-operation will be secured for a project which is of vital importance.

A British Institute of Tropical Agriculture

In dealing with the question of proper provision for technical education in tropical agriculture, as well as in considering other matters of importance to the subject, advance is retarded by the absence of any unofficial society or institution in this country which can claim authority to speak in the interests of British tropical agriculture, and represent the opinions and promote the interests of those who are engaged in what ought to be regarded as an honourable profession. The matter is outside the sphere of any Government Institution, and the International Association for Tropical Agriculture, by reason of its constitution, obviously cannot assume these duties; in fact, British relations with the Association are hindered by the absence of any British society of the kind. Surely the time has come for the formation of a society comprising

all interests in a subject which is so profoundly connected with the welfare of the Empire.

I desire to submit to the British Section of the Association for its consideration, and for such action as it may consider expedient to take, the question as to whether it is not desirable to proceed to form a British Institute of Tropical Agriculture, whose functions would include the holding of meetings for the reading of papers, the discussion of all matters concerning tropical agriculture, and the consideration of education and qualification for the profession, and, in fact, doing whatever it may consider desirable to promote the interests of the subject of tropical agriculture, and of those who are engaged in it. My own experience in the period of twenty years during which I have been closely in touch with the subject, and with those who are working for it in all parts of the world, has led me to the conclusion that action in this direction is much needed, and that the establishment in this country of such an institute on the lines of those of other professional bodies, such as the Institutions of Civil, Mechanical, and Electrical Engineers and the Institute of Chemistry, and many others, would be welcomed by all those who, as specialists, planters, merchants, or manufacturers, are connected with the subject of agricultural production in the British tropics.

A British institute of the character indicated would, of course, be affiliated with the various agricultural societies in the British tropics and with the International Association, and would, with great advantage, take over the work at present performed by the British Committee of the Association.

The best methods by which those countries which are connected with the International Association can co-operate in its work and strengthen its action are to be considered at a meeting of the members of the Association at the close of this Congress. I feel satisfied that the large work which lies before the International Association will be best promoted by a scheme involving the affiliation and close co-operation of a society or institution in each of the European

countries interested in the advancement of tropical agriculture, and our Continental colleagues have expressed the wish that this opportunity should be taken to elicit the views of the British members on this important subject.

Government Departments of Agriculture

The organisation of Government Departments of Agriculture is a subject of much importance, intimately connected with that of technical education. I referred to some of its aspects in a Presidential address to the Section of Chemistry and Agriculture at the meeting of the British Association in 1906. It must be admitted that generally in the British tropics the organisation of Agricultural Departments is still primitive and wanting in principle. Owing to causes to which I have alluded, it is not easy to find a supply of men educated and otherwise qualified to fill official positions of authority in the subject.

It is now recognised that the Director of a Government Agricultural Department in the tropics, or, as he is more usually called, although with some risk of misunderstanding, the Director of Agriculture, should be a man of experience in the practice of tropical agriculture, with such a knowledge of the sciences on which the practice of agriculture depends as will enable him to understand when and how to call to his assistance the members of his staff who are specialists in those sciences. He must also possess administrative ability and the power of organisation. Without this link in the Head of the Department between the scientific staff and the practical agriculturists of the country, whether native or European, the Department will lack effectiveness. A mere assemblage of specialists without a leader versed in agriculture will fail to effect that influence on the advancement of the agriculture of a country which is one of the most essential and at the same time one of the most difficult functions of a Government Department. It sometimes happens that a specialist, it may be a botanist, a chemist, or an entomologist, has sufficient interest in agricultural practice to

make it his study, and if he also possesses other qualifications he becomes a distinguished Director of Agriculture. There are several examples in the British Colonies of such men who have done and are doing eminent service for the advancement of agriculture in their respective countries. These, however, are brilliant exceptions to the rule that a definite system of educating and training tropical agriculturists is better than a want of system in which the right man may eventually emerge by chance. Much the same state of affairs which exists in British countries has until lately been the rule in other parts of the tropics. It is clear, however, that everywhere the movement is now towards a more systematic plan which only needs the provision, through the establishment of a Central College, of the means of technical education in order to secure its general adoption.

The problem of securing as head of an Agricultural Department a man with a broad outlook as well as administrative ability has found a different solution in India. In India the head of a Provincial Department, called Director of Agriculture, is a member of the Indian Civil Service, usually without any knowledge either of agriculture or of any of the sciences on which it depends. He has complete control of the Department and of the specialist staff. He has, as second in command, an agricultural specialist with the title of Deputy Director of Agriculture, on whom must actually, though not nominally, fall the real initiative and control of the Department. The system can only be justified, or rather excused, by the real difficulty of finding trained agricultural officers with those other qualifications which are essential in the head of a Government Department in India, and by the circumstance that besides technical agriculture there are usually involved in the work of the Department purely administrative and legal questions relating to land, with which an Indian civilian is best qualified to deal. I have been in touch with this system for a number of years, and during a recent visit to India I have had further opportunities of studying it.

It must be admitted that occasionally an Indian civilian

has taken great interest in agricultural work, and has made himself an efficient and sympathetic head of the Department. In general, however, the plan has many drawbacks, and so long as it is adopted the best men will not be attracted to the Indian Agricultural Service, in spite of the pecuniary advantages which it offers as compared with the Agricultural Service of the British tropical colonies. I am imformed that it is possible for a Deputy Director of Agriculture in India to become the head of the Department. I am, however, not aware of any instance in which this has actually happened, although the Deputy Director may act as the head of the Department in the temporary absence of the Director. So far as I am aware, an actual vacancy is generally, if not invariably, filled by the appointment of a member of the Indian Civil Service.

Admitting the difficulties at the present time which stand in the way of the creation of self-contained Agricultural Departments in India, I venture to think that some change is now called for in the existing plan. If it is considered impossible to form a separate Department for dealing with administrative and legal questions connected with land tenure, I am inclined to suggest that an alternative might be found in the formation in each province of a small Board of Agriculture, composed of official and non-official members, of which an Indian civilian would be the secretary. The non-official members might well be Indians chosen on account of their interest in the subject. The Director of Agriculture, who would be responsible to this Board, would have full charge of the specialist staff, and would be directly concerned with the technical work of the Department and with the reports which it issues.

The advantages of this system would be that whilst reserving to the Board the consideration of general questions, including those relating to land tenure, the Agricultural Officer would receive his proper title of Director of the Department, and would have the direct charge of the whole of its technical work, and be directly responsible to the Board, whose meetings he would attend.

The Government would still have the advantage of the administrative experience in other than technical questions

of the Secretary and the members of the Board, the Secretary being an Indian civilian with a title—Secretary to the Board of Agriculture—more in accordance with his proper duties.

The inclusion of Indian members in the Board would have the great advantage of securing their interest and co-operation in the agricultural advancement of India, which is so much to be desired.

It is almost a truism that investigation and research should be vital parts of the work of Government Agricultural Departments. The fact that so little is being done in the tropics makes it, however, necessary to consider the question, which is to be discussed at one of our meetings. By research in this connection is not meant the trials and plot experiments which form part of the regular routine work of an Agricultural Department, but the attack and concentration on definite problems by qualified specialists. The reports issued by the various Departments of Agriculture in the tropics, British and other, show that, in general, scientific investigation is not definitely provided for, and that the energies of the usually small staff are being entirely occupied with routine work. It is not every one who is inclined or qualified to deal with the larger questions which await solution as the result of systematic experiment in tropical agriculture, but where such men exist, and they should exist in all Departments, the necessary facilities and assistance should be provided. It will no doubt be said that this involves additional expense, but it is expense which it is well worth while to incur in the interests of the countries concerned.

The amount of expenditure in connection with Government Agricultural Departments in the British tropical colonies, though greater than it was, is still very small in relation to their importance, and to the large amount of valuable work that is being done.

In India the College for Higher Instruction and Research, established at Pusa in Bengal, is now entirely devoted to research on questions of general importance to India. The Central Research Institute, as it is now called, is performing work of great value to Indian agriculture as

a whole. At the same time, its efforts should not lead India to overlook the fact that, with the great diversity of conditions which prevail throughout that great continent, research is also called for in each of the Provincial Departments of Agriculture, where scientific investigation should be chiefly directed to problems of local importance. The results of investigations conducted in one district of Bengal often require re-investigation in their relation to different conditions in other places. The Research Institute at Pusa cannot in any case be expected to deal with all the agricultural research which is called for throughout India, and the prosperity of the Provincial Departments of Agriculture is intimately connected with the power which is given to them of acquiring new knowledge with special reference to problems of local importance.

The International Congress and the International Association

The deliberations of the Congress are to extend to a large number of important subjects relating to the various aspects of tropical agriculture and industries. It will be within the province of the meetings of the Congress to recommend the appointment of Special Committees to collect information on any subject in which it may be considered useful to take action with a view to a report being presented either to the next Congress, or before that event for publication by the International Association.

I have ventured to suggest three questions of general importance for special consideration which it may be convenient to deal with in this way.

(1) The establishment of an Imperial College of Tropical Agriculture, (2) the formation of a British Institute of Tropical Agriculture, which more particularly concerns the British section of the International Association, and (3) the question of the constitution of the International Association considered as a federation of Central Societies in the capitals of European countries, in communication with Agricultural Societies and Institutions in the tropics.

I may now bring this address, already, I fear, too long, to a close with an expression of the hope that the first

meeting of the Congress in the capital of the British Empire may result not only in a satisfactory interchange of views between the representatives of various nations and the advancement of several important matters of tropical agriculture, but also contribute to the formation of those personal friendships between agriculturists of different nationalities which have such a powerful influence in promoting that extension of knowledge which is our common desire.

AGRICULTURAL RESOURCES OF THE ZANZIBAR PROTECTORATE

By F. C. McClellan,

Director of Agriculture, Zanzibar

Position and Geographical Formation [1]

Zanzibar is situated between latitudes 5° 42′ S. and 6° 28′ S.; its length is 46 miles, and its breadth 20 miles. It is separated from the mainland of East Africa by a channel 20 to 30 miles wide.

The island of Pemba lies about 40 miles north of Zanzibar, and between latitudes 4° 50′ S. and 5° 30′ S., the line of longitude, 39° 45′ E., almost bisecting it longitudinally. It is about 40 miles long, with an extreme breadth between the reefs of the west and east coasts of 16 miles.

Geologically Zanzibar is composed of:

(*a*) Hard coral limestone; (*c*) Sand;

(*b*) White or yellow chalky deposits; (*d*) Red earth.

A very soft sandstone is found occasionally, and harder beach sandstone occurs at a few places near the town.

The red earth is formed by the disintegration of the coral rock, and the chalky deposits have probably a similar origin.

The land on the west of the island rises in a series of

[1] The writer is indebted for much of the information contained in this section to two papers contributed to the *Proceedings of the Cambridge Philosophical Society*, Vol. xi., Part III., and Vol. xii., Part I., by Mr. Cyril Crossland, B.A., who visited the Protectorate on the invitation of Sir Charles Eliot, K.C.M.G., H.M.'s Agent and Consul-General.

low, undulating hills to a central ridge or plateau which passes through the centre of the island from north to south, and which at its highest point does not exceed 450 ft.

The coast lands of the east and south of the island consist largely of coral rock, sharp and pointed and difficult to travel over on foot, or by donkey (the usual means of progression where metalled roads have not been constructed).

The soil on the above-mentioned plateau is a red, and in places a yellowish, marl. On the large Government plantation of Marseilles, this red marl extends to a depth of 40 ft. followed by 11 ft. of red and white sand and then 26 ft. of a yellowish marl.

Where not exposed to wind, the red marl is the soil on which clove trees do best; but there must be plenty of depth, as the clove has a tap-root system of growth.

The coral rock, when broken, is hard, crystalline, and yellowish or white.

Pockets of red or black earth are often present; and in such pockets the natives grow their Indian corn and the various millets, Sorghum, Eleusine, Setaria, Pennisetum, and mohogo, and even, in deep pockets, sugar cane. Formerly chillies were largely grown on such soil.

Pemba presents in many ways features common to Zanzibar, namely, a regular and comparatively slight erosion of the more uniformly hard rock of the east coast, and a deeper and very irregular irruption into the west coast, forming long tidal creeks, formerly very useful to the slave-dhows for hiding, now useful for carrying, on the tide, articles of commerce to the heart of the island, and bringing out cloves and copra.

The coral outcrop in Pemba is confined to a strip on the east coast, and to the three northern promontories.

The proportion of land suitable for cultivation is much larger than in Zanzibar.

The island, except for a flat strip following the line of coral outcrop, consists of a series of hills and valleys; the latter mostly swampy in the rainy weather.

The clove-tree grown on the hill-sides, and sheltered

from winds, meets with its true environment in Pemba; and the plantations there are as a rule heavier bearers than those in Zanzibar—age for age.

While Zanzibar is an enlarged portion of the barrier roof of the mainland coast, Pemba is an independent formation.

Climate

Rainfall

The early rainfall records are unreliable, but measurements taken from 1874 to 1878, in the town of Zanzibar, show an average of 61 in. per annum. In the five years 1880 to 1884 the average annual fall in the town was 48·8 in., and in 1892 to 1896, 55·29 in. Pemba has a much heavier rainfall than Zanzibar, and the centre of the island has a heavier fall than the north. No records are available for the south.

The figures for 1899 are:

		Inches.	No. of rainy days.
Zanzibar island:	Town	66·69	144
" "	Dunga	97·94	183
Pemba island:	Weti	96·69	147
" "	Banani	105·24	149

The figures in inches for later years are as follows:

	1908.	1909.	1910.	1911.	1912.	1913.
Zanzibar Town . .	53·62	85·14	50·00	59·14	67·91	53·09
Pemba (Banani) . .	61·33	79·03	83·00	83·40	57·91	86·89

The fear expressed in the seventies that the rainfall was decreasing was no doubt partly due to the unreliability of the earlier figures, and is not borne out by recent figures.

The rainy seasons are well defined. The heavy rains occur in April and May previous to the setting in of the S.W. monsoon. The light rains occur in November and December previous to the setting in of the N.E. monsoon. Some lighter rains, eagerly looked for by the small agriculturist, occur in July.

The planting season for the clove tree and coconut tree in Zanzibar is during the light rains occurring just

previous to the Masika, or heavy rains, and in Pemba in the showery weather following the Masika.

Temperature

The mean temperature in the five years 1874–8 was 80·3° F., and the average yearly range from the highest maximum to the lowest minimum 17·3°. In 1880–4 the average mean temperature was 79·3° with an average yearly range of 23·8°. The average figures for recent years are given in the following table:

Year.	Zanzibar.		Pemba.	
	Maximum.	Minimum.	Maximum.	Minimum.
1909	84·9°	75·9°	81·2°	69·6°
1910	84·4°	76·4°	80·9°	69·7°
1911	84·3°	76·3°	81·8°	70·0°
1912	85·2°	76·6°	81·6°	70·3°
1913	84·9°	76·4°	81·4°	69·8°
Average for 5 years	84·7°	76·3°	81·4°	69·8°

Area and Population

The Sultan's Dominions were originally of very large extent, though the limits of actual sovereignty depended on the martial prowess of the individual Sultan of the day; and all were governed from Muscat.

In 1856 Muscat and Zanzibar became separate Sultanates. In 1890 a part of the coast-line was ceded to Germany, and in 1904 another part to Italy. The other mainland possessions are now leased to the administration of the East Africa Protectorate.

The commercial history of the two islands is closely connected with that of the slave-trade. The status of slavery ceased to be recognised in 1897, and from that date the prosperity of the Arab land-owners has steadily decreased and their properties deteriorated.

The total area of Zanzibar may be taken as 400,000 acres, of which a large proportion is coral outcrop, covered with low bush or grass. The area of Pemba is about 245,000 acres.

According to the census taken in 1910, Zanzibar island had 114,069 inhabitants, and Pemba 85,000.

Zanzibar Town—included in the above figure of 114,069—has about 35,000 inhabitants; and the two chief townships of Pemba, Chaki Chaki and Weti, have 2,000 and 1,000 respectively. Zanzibar island has 175 people to the square mile, and Pemba 219.

Of the Pemba total 72,000 are Swahilis (including freed slaves of various mainland tribes), 10,000 Arabs, and the remainder Indians and others.

The abolition of slavery was followed by a very great increase in venereal disease, consequent on sudden freedom being given to people, especially women, who had been accustomed to strict restraint. The freed-slave class are therefore on this account, and for other reasons, bad breeders, and as a class are decreasing rapidly.

The Arabs having with their slaves lost their former prosperity, and in consequence the frequent intercourse with Muscat and the importation of fresh blood being much less than heretofore, have as a class lost much of their old mental stamina; they do not accommodate themselves to the new conditions of labour, and their days as the leading agricultural community are numbered. It yet remains to be seen who will replace them.

A large number of natives, who were there prior to the Arab conquest, inhabit both islands. In Zanzibar they are called Wahadimu, and in Pemba Wapemba. These people in both islands occupy the less fertile coast-belts, obtaining their living by fishing and growing such crops as maize, sorghum, pigeon pea, etc., and in later years coconuts. They profess Mohammedanism, and were never enslaved by the Arabs. Since the abolition of slavery and the opening up of the islands by roads they are losing their desire for isolation, mixing more and more each year with the general population, and in time may become the chief agricultural class. These people are probably increasing in numbers, but it is difficult to be certain on this point, as the returns of births and deaths from these natives are not reliable.

Of the Indian community, the Parsees are the pro-

fessional class, the Mohammedans the trading class, the Hindoos the money-lending and artisan class; the clerks are generally Goanese.

Plantation labour is provided partly from such freed slaves as live on the land, and partly from the mainland.

The freed slave has become more or less of a parasite on the land-owner. He can never get out of his head the idea, ingrained in it at the time that he received his freedom, that the Government which gave him his freedom, taking away at the same time the sources of his food and living, was bound to provide for him for the rest of his life, and he does not willingly respond to any call to work, regarding it as an injustice. Similarly he objects to pay any ground rent for the land he squats on.

The light plantation work is done more or less unwillingly by the freed female slaves, the males doing nothing; but cultivation as a rule is done almost entirely by mainland natives—generally of the Wanyamwezi and Wakikuyu tribes—who come over in increasing numbers each year, attracted by the rates of pay, which are higher than those prevailing on the mainland.

The clove harvest is almost entirely dependent on the Wahadimu and Wapemba, who each year come more and more into the field. Up to 1904 the former people hardly picked at all, remaining in their coastal villages throughout the harvest. In 1911, however, about 10,000 went up from Zanzibar to Pemba, and in 1913 about 15,000; in the latter year over 11,000 received free passes in the Government steamers. The Wapemba, who up to 1907 had resolutely held aloof from the clove harvest, are also each year responding more rapidly to the requirements, especially now that, coming into touch with town life and shops, their aloofness is conquered by a desire to get money to buy the things which they see. In a good harvest an energetic picker can earn Rs. 2 a day.

As regards labour for the two crops now grown—cloves and coconuts—there is no ground for anxiety, especially as mechanical cultivation may become more general. For any large development in other directions labour would

have to be sought farther afield, or mechanical cultivation would have to be adopted.

Land Tenure and Value

Although the custom is no longer universal, plantations are still generally sold at so much a clove tree or coconut tree, small allowances being made for fruit trees and no allowance being made for the actual land whether planted or unplanted; this probably originated in the Islamic system of tenure, under which a man possessed direct ownership of trees planted by him on waste land, the soil itself remaining the property of the Government. But all these tenures are now practically freehold, just as in England, where land tenure originated in the same idea.

Excepting in the Wahadimu and Wapemba villages, where the tenure often partakes of a communal nature, the boundaries of individual properties, though not so far very clearly defined, are recognised as existing. Where confusion arises, as it often does in Arab-owned plantations, it is generally due to the Mohammedan laws of inheritance, the frequent division at death of large properties, and the inability of the principal heir to buy out the other heirs and keep the property intact.

Great care has therefore to be taken in the purchase of such properties with regard to titles and mortgages; for as regards these latter, nearly all Arab-owned properties are mortgaged up to their full value with the Indians.

It is probable that the Government will shortly commence a survey and deal with the questions of compulsory delimitation, upkeep of boundaries, and registration of titles.

Land occupied by clove trees and coconuts is valued (when that system is followed) at from Rs. 5 to Rs. 9 per clove tree and Rs. 5 to Rs. 6½ per coconut tree in plantations ranging from a good to fair condition of cultivation and health. Of recent years clove trees have decreased in value, while coconut palms have risen.

Reckoning ninety-eight clove trees and forty-eight coconut trees per acre, the value of stocked land ranges from

£33 to £59 per acre for the former, and from £16 to £21 for the latter.

Labour and Rate of Wages

The rate of wages has increased considerably in recent years, as is natural, consequent on public works being undertaken. It is interesting to note that on a plantation on which we now keep a gang of 35 Wanyamwezi to do the necessary hand cultivation the former owner had 500 slaves, and undoubtedly in slave-days the clove plantations were much better kept. They were laid out with the greatest accuracy, and normality was preserved by a strict planting up of all gaps.

After the freeing of the slaves an arrangement was made by the Sultan on the royal plantations, under which the freed slaves worked three days a week on the land in return for being allowed to live on it and cultivate a plot.

Of recent years, however, since the Government took over the Sultan's plantations, owing to the indifferent work of these people, mainlanders have been almost entirely employed, the freed slaves being allowed to live rent free if old or sick, or if they pick cloves at harvest-time.

The Arabs have been foolish in their treatment of this question, and there is a probability that many freed slaves will obtain squatting rights on their former master's land.

In the early nineties some imported Chinese and Indian labour was tried on the Government plantations, but the labourers frequently got fever.

An attempt to import Indian settlers in 1912 was also a failure; but this was probably due to the men being selected from a wrong district.

The Wanyamwezi and Wakikuyu stand the climate well, the former having more stamina.

In 1897 women received Rs. 6 per month and men Rs. 8, both including food money, which in those days would be about Rs. 2 a month. They worked by the day, and the records do not show the cost per acre of cultivation.

Clove-picking was done at the rate of 3 pice a pishi of green cloves, equivalent (*vide* Lyne, *Annual Report*, 1898) to R. 1, pice 13 per frasila of 35 lb. of dry cloves,[1] and this

[1] 4 pice = 1 anna. 16 annas = R. 1. Rs. 15 = £1.

price was maintained through the harvest. Now the price commences on the Government plantations at 4 pice, rising to 6, and on Arab plantations at 4 or 5 pice, rising to 10 or 12 pice a pishi. These latter prices are due to want of foresight and indolence in engaging labour beforehand, so that to get his crop gathered the Arab has to attract his neighbour's labour by outbidding him.

The cultivation of plantations consists of hand-hoeing, and is done almost entirely by task-work, the unit of measurement both in clove and coconut plantations being the planting distance of clove trees, or 21 ft.

A space 21 ft. by 21 ft. is called a pengele, and on the Government plantations a labourer draws Rs. 12 a month of twenty-six working days, his daily task being 7 pengeles, equivalent to about Rs. 6½ per acre. On Arab plantations the task is 6 or 5 pengeles only, equivalent to Rs. 7½ and Rs. 9 per acre respectively.

In Pemba the Government men receive R. 1 for 16 pengeles weeded, which works out also at about Rs. 6½ per acre.

Crops

Cloves

Cloves take the first place, providing a chief source of revenue to the Government and the principal source of the Arabs' former prosperity. They were introduced about 1818, a few seeds being brought from Réunion. By 1860 there was an annual output of 200,000 frasilas—a wonderful tribute to the foresight of the Sultans and the industry of the Arab land-owners. As has been pointed out by Mr. R. N. Lyne, by concentrating their energies on cloves the Arabs became specialists in the cultivation of the tree; their slaves became expert in its planting and in the harvesting of the crop; a community of local merchants settled in the country who are an integral part of the industry, financing, in the absence of co-operative credit, every plantation-owner; and Zanzibar and Pemba, as the producers of over 90 per cent. of the world's cloves possess an importance which would never have been theirs had the Arabs listened to European advice, and substituted the cultivation of other crops for that of cloves.

In 1872 the industry in Zanzibar island was affected by a hurricane which practically destroyed the plantations, but Pemba escaped. The Zanzibar plantations were at once replanted, and therefore date from 1872, whilst many of those in Pemba are 80—90 years old.

The climatic conditions of the islands are peculiarly suited to the clove tree.

The annual market requirements are over 400,000 frasilas, and there is a slight but steady increase in the demand.

The following table shows the exports of Zanzibar cloves, expressed in thousands of pounds, during the period 1903–13:

Year.	Destination.			
	Europe.	America.	Asia.	Africa.
1903	3,551	852	7,560	126
1904	7,312	2,056	4,839	94
1905	5,673	1,769	7,810	59
1906	8,939	717	5,328	92
1907	9,601	1,102	6,553	100
1908	7,197	651	7,050	74
1909	10,638	2,364	7,165	97
1910	4,800	1,096	6,758	128
1911	7,844	3,510	8,706	199
1912	6,067	2,576	6,539	68
1913	8,789	1,975	6,772	275

The harvest may commence as early as July, and may continue as late as March. Seasonal yields are therefore calculated from the deliveries at the Customs (where a 25 per cent. export duty is levied) from July 1 of one year to June 30 of the following year. The following table gives the seasonal yields of the past 10 years:

Season.	Zanzibar.	Pemba.	Total.
	frasilas.[1]	*frasilas.*[1]	*frasilas.*[1]
1904–05	81,313	584,208	665,521
1905–06	78,435	130,635	309,070
1906–07	63,004	203,496	266,500
1907–08	213,662	541,993	755,655
1908–09	65,727	449,691	615,418
1909–10	109,678	300,047	409,725
1910–11	50,196	139,307	189,503
1911–12	216,507	582,153	798,660
1912–13	31,018	104,368	135,386
1913–14[2]	135,399	591,222	726,621

[1] 1 *frasila* = 35 *lb.*   [2] *To end of March.*

There being no agricultural survey and no system of agricultural returns, the area under cloves can only be approximately estimated. Pemba has rather more than two-thirds of the total clove area, with 35,000 to 49,000 acres, and there are in both islands probably between five and six million trees in bearing. The Arabs have long since ceased to raise new plantations, and the area of young woods of 1 to 10 years old is small, a matter which is receiving the special attention of the Government.

Owing to want of experiments, the age at which the clove tree gives its greatest financial return is not known; but it is probably between the thirtieth and fortieth years. In the plantations planted 21 ft. square it is necessary to remove every other tree at about the fortieth year. In Pemba the older woods, from want of thinning, have passed into the pole-forest stage, and will be useful only for shelter-woods for forming new plantings.

Yield experiments also have not been made, and such figures as are available do not indicate very accurately the bearing properties of the trees. A plantation in Pemba of about 4,000 trees, and under efficient white management, yielded in 1913 (a heavy crop year) 20 lb. of dry cloves per tree—the actual crop on trees in bearing being about 35 lb. This plantation bears an average yearly crop of 8 lb. per tree. In the same season trees 10 years old yielded 1¼ lb. of dry cloves per tree. Many of the largest trees in Pemba will, in a good year, yield 60 to 70 lb. of dry cloves per tree. A good crop is obtained once every three to five years, and the average yield of the Arab-owned plantations is about 3½ to 4 lb. of dry cloves per tree per annum.

Apart from the peculiar climatic conditions of these islands, which apparently are very suitable to it, the clove tree requires a deep, well-drained soil, shelter from wind, and ample space. Though shade is desirable when young, full exposure to the sun is necessary for fruiting. On the hill-sides of sheltered valleys in Pemba it is more at home than on the more level ground of Zanzibar.

The tree is comparatively free from disease. A leaf-

blotch which is present is caused, according to a Kew Report, by a harmless lichen. A parasitic alga, *Cephaleurus mycoidea*, Karsten (= *Mycoidea parasitica*, Cunningham), which, according to Ridley, occurs on the clove tree in Penang, has not yet been noticed here. Damage has been observed which may be due to a root-fungus, and specimens are now in England under investigation. A previously undescribed species of fungus of the genus Sphaerella was found at Kew on leaves sent home for examination, and was named *S. vexans*, Massee. The extent of damage caused by this is under investigation.

A Consular Report of 1892 mentions a leaf-eating caterpillar, but no noticeable harm is done by it. Coccids are stated by Ridley to attack cloves in Penang, but no evident damage from this cause occurs here.

A species of Loranthus is met with on most trees in Zanzibar, but has so far not been recorded in Pemba. It is seen especially on those of the citrus family, and is common in neglected clove shambas, as is also the dodder-like Cassytha. Various epiphytic growths occur on all the trees under conditions of old age and unsuitability of locality.

Provided proper attention is paid to the natural requirements of the tree and to its cultivation, the clove tree is more free from insect and fungoid attack than most trees, but, as in the case of all exotic trees, a careful and continuous scrutiny is necessary.

The cloves are gathered by hand, the pickers climbing the trees and drawing the branches towards them by hooked sticks. The method is wasteful, and results in much damage to the trees; but in many cases the trees are too tall for ladders to be used.

The stems are separated from the heads by hand, and the picker is paid for the stemmed cloves only, which are measured or weighed. The proportion of stems to cloves varies with the age of the tree. In a mature plantation of forty years old, 25 to 30 lb. of stems should accompany 100 lb. of cloves. But in ordinary management a much smaller proportion is obtained, as the Arab pays but little attention to them.

Drying is done either on a concrete, cement-faced drying floor, or on mats made from native palms. The former method is of course the best, and under it in fine weather drying is completed in from three to four days. Showers do not cause any harm provided the cloves are spread out on a barbecue and raked over. Drying in the sun does not cause the bud to shrivel, as has been stated; but the shrivelling so common in Zanzibar, and especially in Pemba cloves, is due to heating and careless drying.

Pemba cloves as a general rule fetch a lower price in the local market owing to careless methods of preparation, but those from two plantations which possess barbecues are finer than those from Zanzibar. Under similar conditions of age and soil, and with good management, Pemba plantations give the better results.

The Arab custom of piling the cloves in heaps during wet weather results in fermentation and blackening. Drying under glass has been tried, but with no measure of success. The tray system has been used and abandoned on account of the expense. A hot-air drier was erected by one plantation owner, but in the following year he reverted to the use of his barbecue. Samples of these artificially dried cloves have been examined at the Imperial Institute and an account of the results of their examination was given in this BULLETIN (1912, **10**, 574).

Samples of cloves, stems, and fruits (mother of cloves) were examined this year, and these are dealt with on p. 337. An account of the results of examination of a sample of clove-leaf oil will be found in this BULLETIN (1913, **11**, 438).

One hundred pounds of green cloves will yield about 47½ lb. of dry cloves.

There are at present considerable fluctuations in the price of cloves, and there is much speculation in this spice. The average local price per frasila for the past few years is given in the accompanying table. It is interesting to note that the average price for the three years 1895 to 1897 inclusive was Rs. 4·57 for Zanzibar and Rs. 4·23 for Pemba cloves.

Year.	Zanzibar cloves.			Pemba cloves.			Stems.		
	R.	a.	p.	R.	a.	p.	R.	a.	p.
1907	10	3	6	9	9	0	2	6	0
1908	9	2	0	8	8	0	2	6	0
1909	8	8	9	8	3	6	2	0	9
1910	11	4	3	10	15	3	3	0	0
1911	12	5	3	10	3	6	3	0	9
1912	14	5	0	13	8	3	3	14	9
1913	14	5	3	14	5	3	4	5	9
1914	11	5	6	10	15	0	3	2	6

Coconuts

The coconut comes next in order of precedence, though its importance is of modern origin. The Arabs planted some near their houses for purposes of food, and allowed the slaves, similarly, to plant a few outside their huts. Only rarely are systematically laid out plantations met with.

Of late years planting has been much on the increase, but the method and precision found in the Arab clove-plantings is absent from their coconut fields. Many of the Wahadimu and Wapemba villages consist of coconut groves with the huts beneath.

In the absence of agricultural returns only a rough estimate can be given of the number of trees in the two islands, but there are probably about 2,500,000 covering an area of about 45,000 acres.

Under white supervision the tree yields 80 or 90 nuts per annum on good soil. In the inland plantations the yield is less and the trees come into bearing later.

Five varieties of nuts are recognised, three named according to their colour—white, black, and red—and two varieties of Pemba coconut. No experiments have been carried out with regard to these, but the red variety is regarded as the earliest yielder. Of the Pemba varieties, one is used only for its milk, which is exceedingly pleasant to drink, while the other is used both for copra and its milk.

Given proper cultivation and attention, the coconut tree is much freer from disease in Zanzibar than in many other countries. The rhinoceros beetle occurs here as elsewhere, but its ravages are slight as compared with those reported from other coconut-producing countries. Bud-rot is notice-

able in neglected woods, but where disease is most evident it will be found that the owner does not clean his land, spending what money he can spare on trying to clean his clove-area.

Zanzibar copra is not of very good quality. Its price at present compares unfavourably with that of Cochin and Ceylon copra, but this is entirely due to want of care in its preparation, and to the producer's lack of capital. Samples prepared on the Government plantations have been most favourably reported on. The following extracts are taken from the broker's report:

"Ten bags mentioned as 'sun-dried copra' . . . is a very fine shipment of sun-dried copra and much better than copra sold under the ordinary guarantee of 'fair merchantable sun-dried.' . . . It compares with copra shipped from the Malabar Coast."

The copra is either sun-dried or smoke-dried, the latter process yielding a black product of very inferior quality.

The mean annual output of copra from the two islands for the ten years ending 1912 was 16,000,000 lb. The exports in recent years are shown in the following table:

Year.	*Tons.*	*Year.*	*Tons.*
1904	3,228	1909	3,393
1905	4,718	1910	3,932
1906	4,537	1911	8,110
1907	4,122	1912	7,443
1908	4,654	1913	7,412

The export trade is in the hands of two or three firms, and most of the copra goes to Marseilles.

In addition to the nuts used for the production of copra, large numbers of coconuts are used for food, each native taking at least two a day, and often more, for that purpose.

A certain amount of coconut oil is manufactured in the islands. The values of the combined exports of this oil and of sim-sim (sesamum) oil in recent years are shown in the following table:

Year.	*Value in Rupees.*	*Year.*	*Value in Rupees.*
1904	49,492	1909	32,662
1905	61,543	1910	30,902
1906	46,860	1911	54,673
1907	67,423	1912	49,159
1908	10,280	1913	35,918

Fettered by want of capital, the plantation owners neglect coir fibre entirely, and there are no exports of this. Matting and rope of excellent quality are made in the town jail from home-produced coir, and samples of these are now on view in the Public Exhibition Galleries of the Imperial Institute. A small consignment of matting and rope was recently sold in London, and samples have been examined at the Imperial Institute (see p. 350).

Speaking generally, the conditions of both islands are very favourable to coconut cultivation, and considerable areas of unplanted land await capital for their development.

Rubber

Two rubber-producing plants are indigenous, *Landolphia Kirkii* and *Mascarenhasia elastica*. The rubber exported is obtained almost entirely from the former, which occurs in a small forest in Pemba and in isolated woodland patches.

The Government planted a considerable area with Ceara rubber trees in 1907 in the north of Pemba, but the cultivation has been discontinued, and no yield experiments have been made. The trees were healthy, but the difficulties of labour and supervision in the extreme north of Pemba, where there are no roads, were such as to make further expenditure undesirable.

Samples of Para, Castilloa, and Mascarenhasia rubbers from Zanzibar were examined at the Imperial Institute some years ago and the results of their examination have been published in *Selected Reports from the Scientific and Technical Department, Imperial Institute, Part IV.—Rubber and Guttapercha* ([Cd. 6,022], 1912, pp. 272, 300, 405).

Specimens of the rubbers may be seen in the Public Exhibition Galleries of the Imperial Institute.

The following table shows the exports of Zanzibar rubber during the last ten years:

Year.	Quantity. *lb.*	Year.	Quantity. *lb.*
1904	1,733	1909	2,740
1905	362	1910	4,124
1906	2,995	1911	4,285
1907	988	1912	3,588
1908	1,334	1913	2,220

Copal

At the present time copal is not collected in Zanzibar. It is still to be found there, but the native finds that other work brings him in more money, and the exports of the local product have declined and finally disappeared. Considerable quantities are still shipped from the island, but this consists entirely of material obtained in German East Africa. The amount produced in the latter country, however, has decreased considerably in recent years. In 1888–9 the exports from German East Africa amounted to 652,664 lb. with a value of £27,321. In more recent years the exports have been as follows:

Year.	Amount. lb.	Value. £
1908	266,265	6,926
1909	317,979	7,578
1910	245,449	7,446
1911	209,937	5,369
1912	237,791	5,985

One exporting firm attributes the decline in the German East Africa exports to the exhaustion of the fossil deposits and to the lowness of the price caused by the competition of New Zealand copal (kauri resin), which has been in the market at much lower prices. This firm states that in American markets the demand for East African copal has been killed entirely by the New Zealand product. H.M. Consul at Dar-es-Salaam states that owing to the fall in the price of tree copal (fresh copal) which has constituted the bulk of the exports in recent years, the natives find that it pays them better to work on European or their own plantations. The German report on trade for 1911 states that there is no proof of the correctness of the statement that the deposits of fossil copal are being worked out, but on the other hand the Report for the whole Protectorate states the decline is due to that cause.

The total exports of copal from Zanzibar in recent years are shown in the following table:

Year.	Quantity. lb.	Year.	Quantity. lb.
1904	277,826	1909	263,204
1905	227,704	1910	216,671
1906	256,435	1911	169,261
1907	223,305	1912	213,637
1908	262,184	1913	164,159

Chillies

Chillies were at one time cultivated to a considerable extent by the Wahadimu who occupy the coral strip of the eastern coast of Zanzibar, but the industry has declined in recent years. The quality, when the chillies are properly prepared for market, is extremely good, and in strength and palatability the Zanzibar product is superior to the Japanese, though it is not so bright in colour.

The decline in price, apart from ordinary trade fluctuations, is due to the carelessness of the natives in picking and harvesting, combined with dishonest or improper methods adopted by the town buyer. In 1899 the Government brokers reported very favourably on those sent from the Government plantations, and prepared with ordinary care only.

The exports of chillies have declined recently, as is shown in the following table; but the decline in later years is partly due to the fact that the growers now take a chief part in the clove-harvest.

Year.	Weight. *lb.*	Value. £	Year.	Weight. *lb.*	Value. £
1904	428,881	5,837	1909	103,231	1,304
1905	500,509	4,951	1910	184,383	2,192
1906	290,621	1,877	1911	92,625	1,414
1907	13,627	45	1912	104,720	1,381
1908	30,129	256	1913	76,513	1,042

Cocoa

There is no export of cocoa, and the only planting of any importance was made on the Government Experimental Station in 1898 with seed obtained from Seychelles. The experiments were abandoned by the Government in 1909, and the cultivation has not since been proceeded with. Most of the bushes have disappeared, but the few still remaining are healthy.

The sheltered valleys and humid atmosphere of Pemba are very suitable to cocoa, and capital only is required to make it a valuable adjunct to the agricultural crops of that island.

Sugar

In slave days sugar was largely cultivated by the Arabs, and ruined sugar mills are commonly met with in the Arab-cultivated districts. The industry was at its zenith under Seyyid Barghash in the sixties, and in 1864 £3,000 worth is said to have been shipped from the plantation known as Fraser's shamba. Various causes have contributed to the decay of the industry, chief amongst which was the Arab's labour difficulty on the freeing of his slaves.

Vanilla

In 1897 the Government commenced the cultivation of vanilla with a view to encouraging the Arabs and small native land-owners to grow it; and about 10,000 plants were established at Dunga. The plantations were healthy, and the brokers' report satisfactory, the value of the consignments ranging from 6*s.* to 12*s.* per lb. After twelve years' trial, the Government discontinued the cultivation, as the Arabs and natives would not take it up, and a few Seychelles people are now the only growers.

The last consignment was sent home in 1908 and included some vanilla valued by the brokers at 7*s.* to 8*s.* per lb., and some of inferior quality valued as low as 3*s.* 6*d.* per lb.

Fibres

All the principal fibre-producing plants of the tropics have been grown on the Government Experimental Station at Dunga, but no trials on a commercial scale were carried out. Much of the coral outcrop land of Zanzibar, which comprises about three-fifths of the island, is well adapted for Sisal hemp, and there are some plains in the north-central part of the island which are also suitable, and where the difficulties of cultivation would be less.

Samples of fibres produced experimentally in Zanzibar are now on view in the Public Exhibition Galleries of the Imperial Institute.

Kola

This grows well and is easily raised. Consignments are sent home each year from the Government plantation, and fetch from 4½*d.* to 5*d.* per lb.

Minor Products

In another section of this BULLETIN (pp. 340-350) will be found reports by the Imperial Institute on various minor products grown in Zanzibar and Pemba and sent for examination. It should be pointed out that the Government closed its Experimental Station in 1909, and the products now reported on were obtained from native growers and without selection. With few exceptions the products referred to are not exported, but are only grown for local consumption. In a number of cases the quantity grown is insufficient to meet the local demand and considerable amounts are imported, as is indicated in the following table:

IMPORTS OF AGRICULTURAL PRODUCE, TIMBER, AND STOCK

Value in hundreds of rupees

Year.	Rice.	Maize.	Sugar.	Tobacco.	Timber.	Cattle.	Goats and sheep.
1904	85	50	1,123	719	199	1,277	1,386
1905	1,104	182	1,285	1,008	852	1,322	1,251
1906	1,491	190	1,473	893	1,016	1,304	1,019
1907	2,825	308	1,578	1,455	729	1,324	1,361
1908	22,221	217	2,471	1,220	904	1,622	1,565
1909	18,769	247	3,441	894	864	1,706	1,382
1910	16,441	152	3,552	1,253	272	1,452	1,409
1911	20,764	212	3,620	1,051	839	1,720	1,570
1912	26,106	267	4,399	1,477	911	1,932	1,779
1913	22,903	266	4,136	1,829	1,033	1,326	1,139

Cassava is the principal food of the native and is only grown where there are native huts. Both the sweet and bitter kinds are cultivated, and the native recognises under local names many varieties, of which one is pre-eminent.

Several varieties of hill and valley rice are cultivated. Rice forms one of the staple articles of food of the Indians, Arabs, and natives, and is now grown by the last-mentioned in small patches only. A number of samples of unhusked

rice from Pemba were examined at the Imperial Institute last year. Specimens which had been husked at the Imperial Institute were submitted to two firms of merchants in London, who reported favourably on them and valued them at 10*s.* to 10*s.* 6*d.* per cwt. in London (see this BULLETIN, 1914, **12**, 102).

Maize is grown locally by the natives for food, and several varieties are recognised under native names.

Sorghum vulgare is largely cultivated by the Wahadimu and Wapemba for food. Varieties of Eleusine, Setaria, and Pennisetum are cultivated also by the same classes for food, especially in the coral out-crop districts where they principally live. Specimens of these millets grown in Zanzibar have been examined at the Imperial Institute (see p. 340).

Vigna Catjang, *Phaseolus Mungo*, *Dolichos Lablab*, and *Cajanus indicus* are in common cultivation by all natives for food. The results of examination of samples of these seeds from Zanzibar are given on p. 342.

The ground nut (*Arachis hypogaea*) and the Bambarra ground nut (*Voandzeia subterranea*) are grown to some extent for food. For the results of examination of samples of these seeds from Zanzibar see pp. 345, 348.

Cinnamon was grown on the Government Plantation at Dunga, but its cultivation was given up when the Government abandoned the experiments at this station. Some few hundred nutmeg trees are grown on the Government plantations; these are healthy and bear well. The cultivation of ginger, like that of chillies, has fallen off. Pepper is grown occasionally.

Sim-sim (sesamum) is grown by Arabs and natives and sold to local oil-mills. The results of examination of two varieties of sim-sim from Zanzibar are given on p. 346.

Jatropha Curcas is commonly grown as a boundary plant. The oil of the seeds is used locally by natives, and the plant is employed as a support for vanilla. A sample of this seed from Zanzibar has also been examined at the Imperial Institute (see p. 347).

Moringa pterygosperma is used as a boundary for com-

pounds in villages. The oil is occasionally used by natives. A sample of moringa seed from Zanzibar has been examined at the Imperial Institute (see p. 348).

Telfairia pedata is grown by the Wahadimu in Zanzibar and the oil used by them for anointing purposes. An article dealing with these seeds, and including an account of the examination of a sample from Zanzibar, was published in a previous number of this BULLETIN (1912, **10**, 223).

The castor-oil plant is grown in patches by natives and the oil used for medicinal and anointing purposes. An account of the examination of a sample of castor seed from Zanzibar is given on p. 349.

The oil palm is indigenous, and the fruits are collected in Pemba for sale locally. The exports of oil-palm products are small and are not shown separately in the official trade returns. For the results of examination of a sample of palm nuts from Zanzibar see p. 349.

Kapok (*Eriodendron anfractuosum*) is a common boundary tree, the floss being used locally for mattresses and pillows. That produced on the Government plantations sells in the United Kingdom for 5½*d.* to 6*d.* per lb. The seeds contain an oil similar in properties to cotton-seed oil, and specimens from Zanzibar have been examined at the Imperial Institute (see p. 347).

The soap-berry tree (*Sapindus saponaria*) is cultivated by Arabs and natives on a small scale, and the berries are used for washing purposes.

Tobacco is grown locally, especially in Pemba, for chewing; for this purpose the tobacco is mixed with lime and a chip of areca nut and wrapped up in a leaf of the betel vine (*Piper Betle*). The betel vine is cultivated in Wahadimu and especially in Wapemba villages, and sold for the above purpose, 320 leaves fetching R. 1. The areca nut is common on all plantations.

Of the cultivated fruits, the oranges from trees planted by Arabs in their days of prosperity are equal to any in flavour; and this applies also to pine-apples, which are a common weed on neglected plantations, and the cultivated varieties of which are extremely fine. The

mango has become naturalised all over the two islands and abounds in neglected clove and coconut plantations. Bombay varieties originally imported by the Sultans are very good. The Otaheite apple (*Spondias dulcis*), tamarind, papaw, guava, rose-apple (*Eugenia Jambos*), custard apple, sour-sop (*Anona* sp.), date, fig, Malay apple (*Eugenia malaccensis*), sapodilla, avocado pear, litchi (*Nephelium Lit-chi*), bullock's heart (*Anona* sp.), pomelo or shaddock, mandarin and tangerine oranges, lime, sweet lime, lemon, citron, durian, jack-fruit, bread-fruit, bread-nut, cashew nut, African almond (*Terminalia* sp.), pomegranate, granadilla, etc., are all of common occurrence in Arab and native gardens.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

THE UTILISATION OF FISH AND MARINE ANIMALS AS SOURCES OF OIL AND MANURE

Part II.—MANURE

The first part of this article (this Bulletin, 1914, **12**, 251), dealt with oils obtained from fish and marine animals and included an account of the present position of the whaling industry. The present part deals with the utilisation of fish and marine animals as sources of manure, with fish meal as a cattle food, and with fish glue.

For considerably over a century waste fish, in various forms, has been employed as a manure. The most primitive method of use is that of applying the fresh fish direct to the land and, after it has decomposed sufficiently, ploughing it in. This method is still employed in many localities where there is an abundance of fish unsuitable for food or when there is a glut of edible fish. Thus at Cape Spear, in Newfoundland, large quantities of capelin, a variety of sardine, annually visit the surf and are caught for use as a manure.

This method has the disadvantage that a considerable proportion of the nitrogen present in the fish is lost as

gaseous ammonia during the putrefaction, and further, the material cannot be stored profitably for future use. It is also stated that the continued use of oily fish, such as herring or sardine, in this manner has a detrimental effect on the physical condition of the soil. These, and other difficulties, led to the modern practice of making fish manure

Manufacture of Fish Manure

The manufacture of fish manure is undertaken, in many localities, merely as a means of profitably disposing of fish residues. The chief exception to this is the extensive menhaden fishery carried on along the Atlantic seaboard of the United States solely for the manufacture of oil and manure (*loc. cit.*, p. 258).

The methods used in the manufacture of fish manure and oil vary greatly in details, but speaking generally the process is carried on in three stages: (1) cooking the fish to soften the tissues and facilitate the removal of the oil; (2) pressing the cooked mass in order to remove oil and water; (3) drying the residue. The following account of the manufacture of fish manure applies especially to the menhaden industry of the United States, but the processes are applicable to the manufacture of manure from almost any kind of fish; in those, however, such as cod, dog-fish, and shark, which have the oil largely in the liver, the latter is removed and treated separately. The older methods, involving the use of open vats and either hydraulic or hand presses, can be adapted for use on a small scale, but the more modern methods, in which continuous cookers and presses are employed, are obviously only suitable for large factories.

Cooking.—In the older methods this operation is performed in open vats having a capacity ranging up to 20,000 fish (six tons), constructed of metal, wood, or cement, and having a false bottom, beneath which are steam pipes. The fish are automatically conveyed to the vats from the storage bins, and cooked, by steam, for about twenty minutes. The vapours from the cookers are sometimes led into condensing towers in order to avoid pollution of the

atmosphere by the objectionable odours produced during the operation.

The cooking must be prolonged sufficiently to render the fish easily broken, but must not be such as to cause complete disintegration, as this produces a soft, slimy mass from which it is difficult to separate the oil.

In the more modern methods the cooking is done by means of steam, in an iron cylinder which measures about 40 ft. in length and 2 ft. in diameter. Through this vessel, which is stated to be capable of dealing with about thirty tons of fish per hour, the fish are conveyed by means of a screw. The steam is admitted to the cylinder by various means, such as through hollow blades or hollow shafts of the screw conveyor or by numerous inlets in the bottom of the vessel. In this process the cooking is carried out much more rapidly than when open vats are employed.

Pressing.—In the old process the fish, when sufficiently cooked, are conveyed mechanically from the vats to the curbs of the presses, the surplus water and oil being allowed to drain away to the storage tanks of the oil room. The presses employed are mostly of the hydraulic type, although there are a few hand-operated screw presses still in use. As the pressure is gradually applied, the mixture of oil and water which drains away is caught by a sloping floor and passes to the oil room for further treatment (see p. 434). When the pressing is complete the curb is released and the pressed cake, now termed "green scrap," is discharged into the storage room below. The green scrap, which still contains about 50 per cent. of water and 6 to 9 per cent. of oil, requires to be further treated to prevent putrefaction and consequent loss of ammonia. This can be done either by drying the scrap or treating it with sulphuric acid. The older method of drying consisted in exposing the green scrap, spread on wooden or cement platforms, to the sun for about three days. As this process was entirely dependent on the weather, it has now been largely superseded by the hot-air drier described later (see p. 432).

If the scrap cannot be dried at once, or if fermentation has already started, it is spread in thin layers on platforms

and treated with a solution containing 62·5 per cent. (by weight) of sulphuric acid (oil of vitriol), about 90 lb. of the solution being used for 2,000 fish. Another process consists in heating the green scrap in "process kettles" with 5 per cent. sulphuric acid for one hour with steam at 20 lb. pressure. The acidulated scrap is either sold in the wet state for compounding with other manures or dried. Analyses of these products are given on p. 435.

In the newer continuous process, the cooked fish, together with the liberated oil and water, pass from the end of the cooker to a bucket conveyor and thence to the presses. The modern automatic continuous screw press consists of a horizontal tapered screw built on a hollow shaft and fitting closely inside a similarly tapered slatted curb. The cooked fish are fed into a hopper on top of the larger end of the press and travel forward by the rotation of the screw, being thus subjected to a gradually increasing pressure which is regulated by a cone adjustment at the smaller end of the press where the mass is ejected. The expressed mixture of water and oil drains away between the slats and is run to the oil room. It is claimed that the continuous screw press gives a product containing less water and oil than does the hydraulic press. This is a matter of considerable importance both as regards the yield of oil and the quality of the manure.

Drying.—In most of the modern factories the pressed scrap is dried in a hot-air drier. This consists of a rotating insulated iron cylinder 30 or 40 ft. long and about 6 ft. in diameter, provided inside with a series of projecting shelves 8 in. wide running the length of the cylinder. The feed, or front end of the drier, is set slightly higher than the exit end and is enclosed in a brick chamber which also constitutes the fire box. The scrap from the presses is fed into the drier and immediately comes into contact with the hottest gases from the fire box. By means of a fan the furnace gases are forced forwards, carrying with them the finer particles of the fish. The rotation of the drier and the projecting shelves in the latter cause the pressed scrap to be repeatedly taken up and scattered through the hot gases and at the same time to travel

slowly forward. Driers are also in use in which the incoming hot gases travel in the opposite direction to the wet scrap, so that the driest product comes in contact with the hottest zone of the drier. The time taken by the scrap to travel through the drier varies from 3 to 40 minutes, depending on the size of the pieces and the rate of the blower. In passing through the drier some of the smaller particles become partially burned and give rise to a most offensive odour. Attempts to prevent the pollution of the atmosphere by these gases have been made by using high chimney stacks, and by blowing the exit gases through water. The fish scrap on leaving the drier usually contains about 7 per cent. of moisture. It is conveyed to bins, where it is stored until the fishing season is over and labour is available for putting it into sacks. In the United Kingdom, the drying of the scrap is often done by means of a steam drier, especially when the scrap is to be used as cattle food. The general arrangement of steam plant is somewhat similar to the hot-air drier described above, but the heating is effected by means of a series of parallel steam pipes arranged in the form of a ring.

A method for the conversion of small quantities of fish into a fairly efficient manure may be of value to those who wish to work on a small scale without the use of special plant. A hole of suitable dimensions, say 6 by 6 by 5 ft., is dug in the ground and lined inside with clay. At the bottom is placed a layer, a few inches deep, of wood ashes, followed by a layer of fish sprinkled with lime. This succession is repeated until the hole is nearly full, and then a layer of earth is added and the hole closed by weighted boards. After being left for several months the mass is thoroughly mixed and is then ready for use as manure.

Cost of Plant.—It is somewhat difficult to estimate the total cost of the plant necessary for a fish manure and oil factory, as the situation of the works, the proposed output, and the nature of the fish to be treated largely influence the cost. The following is an approximate estimate, supplied by a well-known British firm for the

plant necessary to treat 30 tons of herring or similar fish per day:

	£
Three 1-ton cookers with agitating gear	240
" hydraulic presses	300
" horizontal driers (13 ft. by 6 ft. 6 in.)	1,050
One Lancashire steam boiler (30 ft. by 7 ft.)	450
One steam engine	195
Four cutting machines (two steam)	400
Two hydro-extractors	260
Six steel tip-wagons and two oil tanks	125
Grinding plant	317
Feed pump, connections between plant, shafting, goods, lift, etc.	511
	£3,848

A plant recently erected on the Pacific coast of the United States for the treatment of 100 tons per day of dog-fish, skate, mud-shark, rat-fish, and similar fish, consists of four steel cookers for fish and a similar number for livers, a hydraulic press, steam drier, triple-effect evaporator for making fish glue from the tank waters, and the necessary storage tanks. The power plant comprises two 125 horse-power tubular boilers, a 50 horse-power engine, and one 75 kilowatt electric generator. The entire plant cost £10,400, f.a.s., New York.

Several attempts have been made, in the United States, to utilise the fishing vessel as a floating factory and so save time during the fishing season. One of these vessels is a converted steel dredge of 5,000 tons, having a capacity for 5,000 barrels (446 tons) of fish. It is fitted with the usual plant used ashore, and when necessary calls by wireless telegraphy the vessels which convey the scrap and oil ashore. This floating factory has the advantage of being able to utilise fully a good shoal of fish, but some difficulty is experienced in getting an efficient separation of the water and oil.

Separation of Oil.—The mixture of oil and water, obtained from the various operations detailed above, is run into tanks in order to let the water and finely divided fish ("gurry") separate from the oil. The process is often assisted by gentle heating by means of steam coils. When separation has taken place the oil is run off and purified.

The water containing the gurry is subjected to various processes depending on whether it is desired to produce from it fish glue or a further quantity of manure. If the latter is desired, the gurry which separates out is pressed in order to get a further quantity of oil, and the pressed cake added to the scrap. At some works the aqueous liquid is evaporated to dryness in a multiple-effect evaporator, and the solid residue added to the manure already obtained. The process for the manufacture of fish glue is briefly described on p. 442.

Materials employed in the Manufacture of Fish Manure

Practically any variety of fish can be used for the manufacture of manure, but at the present time a very large proportion is obtained from the inedible menhaden (see this Bulletin, 1914, **12**, 258). Of less importance as a raw material is the waste obtained by dressing herring, cod, sardine, and other edible fish.

Menhaden.—The important constituents of several varieties of menhaden scrap are shown in the following table:

	Nitrogen. N.	Phosphoric acid. P_2O_5.	Moisture.	Oil.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Dry scrap (cargo sample)	8·96	7·75	6·18	6·81
Sun-dried scrap (ground)	7·81	5·85	7·46	7·89
Dried acidulated scrap	8·00	7·52	6·30	—
Undried ,, ,,	5·90	4·89	45·40	—

The content of potash (K_2O) is variable, but averages 0·5 per cent. for scrap containing 10 per cent. of moisture. Estimates for the yield of manure vary to some extent, but as an average it may be taken that 15,000 fish (4·5 tons) will give one ton of dried scrap.

The production of fish manure (chiefly from menhaden) in the United States, in 1912, was 50,000 tons of dried scrap and 28,000 tons of acidulated scrap, having a total value of £416,666.

Cod.—Little manure is made from the whole fish, but

large quantities are produced in Norway from the waste resulting from the dressing of cod. As the fish contains but little oil in the flesh, it is unnecessary to submit it to any cooking process, the material being usually reduced to a fairly small size and dried first in the open air and finally in kilns. The manure, which on leaving the kilns contains about 12 per cent. of moisture, is finely ground between millstones, and is then ready for sale. Owing to the large percentage of phosphoric acid in cod heads, which constitute a large proportion of the waste, the manure is especially rich in this constituent. The percentage of nitrogen, phosphoric acid, and water in two varieties of cod manure are shown in the following table:

	Nitrogen. N.	Phosphoric acid. P_2O_5.	Water.
	Per cent.	*Per cent.*	*Per cent.*
Cod heads	6·5	20·0	3·5
,, waste	8·0	14·9	13·0

No statistics are available as to the quantity of manure made from cod in Norway, but the total production of fish manure for 1911 was 10,369 metric tons valued at £77,800.

Herring.—Large quantities of manure are made in the United Kingdom, Russia, Japan, Norway, etc., both from the whole fish and also from the waste resulting from kippering and salting herrings. The process used is similar to that employed for menhaden (see p. 430). A certain amount is also converted into meal for feeding stock (see p. 441).

The composition of some commercial brands of herring manure is shown in the following table:

Source.	Nitrogen. N.	Phosphoric acid. P_2O_5.	Lime. CaO.	Fat.	Water.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sakhalin (i) .	10·28	6·75	6·21	5·81	9·80
,, (ii) .	10·92	4·27	2·91	6·24	10·63
Vladivostok .	11·77	4·85	4·46	11·61	6·66

Dog-fish.—As was mentioned in the previous part of this article (*loc. cit.*, p. 257), in certain parts of the world

so much damage has been done to the local fisheries by dog-fish that measures have been taken to reduce the numbers of this fish. This has been particularly the case on the North Atlantic coast of Nova Scotia, where the problem has been attacked by offering the fishermen a bounty of $4 per ton of dog-fish caught, and by establishing works for converting the dog-fish received into manure, oil, and fish glue.

Such works are in operation in Canada at Canso and Clark's Harbour in Nova Scotia, and Shippigan on Chaleur Bay, New Brunswick. It would appear, from the fact that the manure first made at these works often contained 30 per cent. of oil, that the fish were treated whole. Recently, however, the livers have been removed from the fish before the latter are cooked, and a product containing approximately the following percentages of the chief constituents is now on the market:

Nitrogen	N	9
Phosphoric acid	P_2O_5	4
Water		12
Oil		2

It will be noticed that in comparison with the manure made from menhaden (p. 435) that obtained from dog-fish is low in phosphoric acid. This is due to the fact that the skeletons of fish of the dog-fish class (selachians) consist of cartilage and not bone as in the case of most other fish.

Sardine.—Fish of this class are used for making manure in Japan, Madras, and elsewhere, and the refuse from the sardine canneries of Brittany is also used for this purpose. The cannery waste, consisting of heads, cartilage, and intestines, is allowed to drain, and in Brittany the liquid, which contains about 1·3 per cent. nitrogen, is used to enrich farmyard manure, about four to six barrels being applied to each acre of land.

The solid portion of the waste is converted into manure by the process already described. The yield of manure varies, but usually one ton of waste will give about 470 lb. of manure containing 10 per cent. of water. The composition of manure made from sardine offal is given in the

following table, and analyses of samples from Madras were quoted in this BULLETIN (1914, **12**, 54):

	Brittany.	Japan.
	Per cent.	*Per cent.*
Nitrogen N	6·50	8·0 to 11·7
Phosphoric acid P_2O_5	13·16	2·9 „ 4·9
Potash K_2O	—	0·16 „ 0·76
Lime CaO	—	2·1 „ 4·6
Water	5·0	5·7 „ 16·3

Salmon.—A large amount of waste results from the dressing of salmon preparatory to canning; it is stated that often one-fourth of the total salmon handled becomes waste, and in Alaska a certain proportion of this is converted into manure.

Fish Trades Waste.—The waste fish from the larger markets forms the chief source of the raw material for the manufacture of fish manure in the United Kingdom. Certain of the larger towns, where, formerly, the disposal of this waste was a difficult and expensive matter, now pay 10*s.* per ton for fish waste delivered at their works, but where the material has to be collected the rate of payment is much less.

The method of treatment adopted is very similar to that used for menhaden (p. 430), except that the material, before being cooked, is reduced to a standard size by means of a rotary cutter, and the superfluous water is removed by means of centrifugal machines.

In this connection it is interesting to note that the damaged fish resulting from the fish-curing industry of Sunamganj, Assam, is utilised locally as a manure for vegetables and tobacco. The constituents of manurial value in three varieties of this product are shown in the following table:

	"Chanda."	"Tangra."	"Bhera."
	Per cent.	*Per cent.*	*Per cent.*
Nitrogen N	8·49	7·84	9·57
Phosphoric acid P_2O_5	6·77	6·84	5·09
Potash K_2O	1·32	1·10	1·21

Whale.—On certain coasts where the whaling industry is carried on (see this BULLETIN, 1914, **12**, 264), if the whale

meat is brought to shore it is often converted into manure. One of the processes in use for this purpose is the following: After the removal of the blubber and other fat, the flesh is cut into small pieces and cooked, by steam under 40 lb. pressure, on iron trays in an iron cylinder. The cooking lasts for about 10 hours, and the flesh is then pressed and dried. The latter operation is carried out in horizontal brick chambers, each about 25 ft. high, and having a central revolving shaft which carries trays upon which the cooked flesh is spread. By means of scrapers the flesh is gradually passed to the lower shelves, and to the exit at the bottom. The bones are often dried, ground, and added to this manure. The percentage composition of whale manure is approximately: nitrogen, 7.5; phosphoric acid, 13·5; lime, 16·5; water, 5·0.

Complete statistics of production of whale manure are not obtainable, as some of the larger producers do not distinguish between whale and herring manure.

The production of whale guano in Newfoundland was 523 tons in 1913, as compared with 655 and 672 tons in 1911 and 1912 respectively. Considerable quantities are produced in British Columbia, the amount marketed in 1912–13 being 1,484 tons, valued at £11,592. The exports from the Union of South Africa in 1912 and 1913 were 2,520 tons, valued at £16,694, and 651 tons, valued at £3,619 respectively. In the Falkland Islands both whale oil and manure are produced. In the 1911–12 season 30,270 bags of the latter, valued at £14,872, were produced in South Georgia.

Crabs.—For a number of years the horseshoe crab (*Limulus polyphemus*) was caught along the Atlantic coast of the United States for the purpose of making manure. The crabs were chiefly taken by means of pound nets when they visited the shore during the spawning season. At the present time the waste from certain crab canneries in the United States is dried, ground, and sold as a "filler" for fish manure. A partial analysis made in the Soils Bureau of the United States Department of Agriculture of such a product gave the following percentage results: Nitrogen, 3·82; phosphoric acid, 4·55; moisture, 6·95; oil, 2·11.

Lobsters.—The refuse from the lobster canneries in Nova Scotia, New Brunswick, and elsewhere is used in much the same way as crab waste. Lobster-shells contain, when dry, about 4 per cent. of nitrogen, 3 per cent. of phosphoric acid, and 20 per cent. of lime.

Shrimps.—The shells and the refuse from the preparation of canned shrimps form a manure much favoured by the Chinese on the Pacific coast of the United States. The manure is said to be specially suited for the manuring of strawberries and vegetables in California, and to be much used in China for manuring rice and tea.

Manurial Value of Fish Products

The analyses of fish manures quoted above show that these products are all deficient in potash, and for this reason much of the fish manure made in the United States is not sold to the farmer as such, but is used as a component of a complete manure. As the nitrogen in fish manure is largely in an organic form, it becomes available for plant nutrition more slowly than if it were in inorganic form, *e.g.* as in ammonium sulphate or potassium nitrate. It thus happens that the nitrogen in fish manure is not so readily leached out of the soil as are the inorganic forms, and so is supplied to the plant during the whole season. It is stated, however, that it is more readily available than the nitrogen in dried blood, steamed bones, or hoof meal. The phosphoric acid in fish manure soon becomes available for plant nutrition, and as regards the availability of this constituent, fish manure is stated to be about equal to steamed bone, and superior to tankage, hoof meal, and wool waste.

The following percentage figures are of interest as indicating the condition of the phosphoric acid in ordinary dry scrap and in the wet and dried forms of acidulated scrap :

	Acidulated scrap.		Dry scrap.
	Wet.	Dry.	
Water soluble phosphoric acid	1·17	0·55	0·44 to 0·66
Citrate " "	1·13	2·64	3·1 to 5·14
Insoluble "	2·58	5·06	1·7 to 3·3
Water in scrap	45·4	12·5	about 12

For the production of a complete manure from fish scrap of the type yielded by dog-fish, the following formulæ have been suggested by F. T. Shutt (*Canadian Exp. Farms Rep.*, 1906, p. 161):

	A. *lb.*	B. *lb.*
Fish meal	300	300
Nitrate of soda	100	50
Superphosphate of lime	300	400
Potassium chloride	50	150

A is stated to be suitable for cereals and grass, and B for potatoes, root crops, and clover.

Fish manure finds extensive use in the United States, Japan, etc.; in the United Kingdom it has been for many years a favourite with hop-growers, and is also used for root crops.

The manure should be ploughed into the land early in the year, as, like many other products of its class, it is somewhat injurious to germinating seeds until it has been in the soil for some little time and the more active fermentation is over. Fish manure gives the best results when used on moderately light, moist soils which contain a plentiful supply of lime.

Fish Meal as Cattle Food

Fish meal has been used with some success as a supplementary food for stock. It has also been successfully used in carp-ponds, but for this purpose it must be free from bones.

Various grades of meal made from cod, herring, or fish trades waste are now on the market. The results of partial analyses of certain of these are given below:

	Phosphoric acid. P_2O_5.	Lime. CaO.	Nitrogen. N.	Protein.	Fat.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Norwegian cod meal	10·9 to 12·8	—	—	50 to 60	1 to 2
Herring meal	3·6 ,, 4·6	—	—	60 ,, 70	10 ,, 12
English waste meal	6·4 ,, 8·2	—	—	55 ,, 65	3 ,, 6
German meal	—	—	—	59·8	2·53
Scotch ,,	5·84	—	8·57	—	14·9
English ,,	5·20	4·90	11·83	—	—

It is stated that the horned dog-fish, *Squalus acanthias*, is sometimes dried and used for feeding purposes in Scotland, Ireland, Norway, and elsewhere.

Cod meal may be made by simple drying and fine grinding of the fish, but in the case of the herring it is necessary to remove most of the oil by the usual process of cooking, pressing, and drying (see p. 430).

It is stated that good fish meal for feeding purposes should contain not less than 8·2 per cent. of nitrogen and not over 5 per cent. of oil.

Fish Glue

This product is made at many fish manure factories from the water in which the fish have been cooked. The aqueous liquid is separated from the oil and gurry (see p. 434), and clarified by the addition of a small quantity of alum. The solution is then filtered, concentrated to a strength representing 32 per cent. of dry glue, and bleached, if necessary, by means of sulphur dioxide.

The material is used by shoe manufacturers, bookbinders, and makers of boxes, musical instruments, artificial flowers, etc. The glue sells usually at about £1 10*s*. to £2 10*s*. per cwt.

TIN RESOURCES OF AUSTRALIA, SOUTH AFRICA AND NIGERIA

In a previous article an account was given of the tin deposits of the Malay Peninsula and Burma (see this Bulletin, 1914, **12**, 278). The Australian, South African and Nigerian occurrences are described in the following pages.

Australia

The most important tin fields of Australia are situated in Tasmania, Queensland and New South Wales. In 1912 the output of tin and tin ore from the different States of the Commonwealth was as follows:

		Quantity.	Value.
		Long tons.	£
Tasmania	ore	3,713	543,103
Queensland	"	3,230	364,503
New South Wales	metal	900	338,074
	ore	1,175	
Western Australia	"	575	70,578
Northern Territory	"	270	27,001
Victoria	"	48	5,733
	Total value		£1,348,992

The tin-producing States will be considered in geographical order, beginning with the north-east of the continent.

Queensland

The fields producing tin ore in 1912, with their output, were as follows:

	Quantity. tons	cwts.	Value. £
Herberton	1,927	0	209,893
Chillagoe	504	0	51,777
Cooktown	272	0	36,233
Stanthorpe	166	5	21,428
Kangaroo Hills	163	0	20,340
Charters Towers	75	5	9,286
Etheridge	57	0	6,775
Palmer	37	5	5,006
Croydon	15	0	1,893
Ravenswood	13	5	1,848
Nanango	0	3	24
	3,230	3	364,503

All the tin fields are in the northern part of Queensland with the exception of Stanthorpe and Nanango, which are near the southern border.

The Herberton and Chillagoe tin fields are situated to the south-west of the port of Cairns, with which they are connected by railway. The country near Herberton is among the most mountainous in Queensland, ranging from 2,000 to 4,000 ft. above sea-level. It is traversed by the main dividing range of the State, while the Herberton Range on the eastern border prevents easy access to the coast. The rocks are slates, schists, and quartzites, with intrusions of biotite or hornblende granite, granite porphyry, or quartz felsite. Elvan dykes intrude into both the

plutonic rocks and the altered sediments. The tin lodes occur in an irregular manner. The lode material as a rule merges gradually into barren country rock, and varies from unaltered granite or quartzite to greisen and chloritic or kaolinic material. The tinstone (cassiterite) is often accompanied by topaz, fluorite, tourmaline, wolframite, bismuthinite, antimonite, galena, chalcopyrite and magnetite. Alluvial tin was first worked in this district in 1880, and the discovery of lodes near Herberton and Watsonville soon followed. Irvinebank, Koorboora, Stannary Hills, Sunnymount, and Newellton are other important lode-mining centres in these fields.

Farther north, in the Annan River tin field, south of Cooktown, the output is almost entirely stream tin, although lodes have been worked to some extent in the past. The district is one of rugged granite mountains, but the streams draining westward into the Annan River are held up by bars of harder rock, giving rise to an alternation of cascades and quiet reaches in which extensive alluvial deposits occur. Some of these deposits have been worked continuously for tin since the opening of the field in 1886. To bring water to the higher terraces, races had to be constructed, often several miles in length; water supply is a most important factor in many of the Queensland fields, and a dry season leads to a diminished output of tin.

The Kangaroo Hills tin field, about 100 miles south of Herberton, produced lode and alluvial tin in about equal quantities in 1912. Lodes have recently been discovered at Watercress.

Still farther south, in the Charters Towers district, a certain amount of lode-mining for tin is carried on, but the industry is quite overshadowed by the gold production of the district.

In the Stanhills tin field, near Croydon, cassiterite occurs in veins in granitic rocks, and is associated with chlorite, quartz, pyrite, galena, sphalerite and chalcopyrite. The Desert Sandstone, which overlies the granite and forms isolated flat-topped hills, is stanniferous in places. Alluvial deposits have been worked, but these

are not extensive and are of less importance than the lodes.

In the Stanthorpe district, near the New South Wales border, the first discovery of tin ore in Queensland was made in 1872. Lode mining has produced very little tin, but the alluvial deposits are still yielding good returns to modern methods of extraction, particularly dredging.

Cassiterite occurs, associated with gold, platinum and monazite, in the shore sands near Currumbin Creek, in the south-east of Queensland. Similar deposits are found on the coast of New South Wales.

New South Wales

The principal tin fields of New South Wales are situated in the north-east of the State, in the Inverell and Emmaville districts. Tin was first worked at Elsmore, near Inverell, in 1872. Here the cassiterite occurs as crystals disseminated through granite and greisen, and, on the decomposition of the rock, has become concentrated in surface deposits. It is associated in these deposits with some wolframite, and also with carbonate of bismuth. The wolfram is derived from lodes which intersect the granite, but which do not appear to be stanniferous.

Shallow alluvial deposits were soon discovered, and for the most part worked out, in the surrounding district, as at Newstead, Stannifer, Tingha, and Stanborough.

The bed of Cope's Creek, and also the alluvial flats bordering it, were rich in cassiterite. At Tingha, on this stream, dredging for tin was commenced in 1900 for the first time in New South Wales. In 1912 two-thirds of the total output of the State was furnished by dredging plants, of which there were thirty-five of the suction-pump type, and only four bucket-dredges. The suction-pump dredging method is really a form of hydraulic sluicing, steam pressure taking the place of a natural head of water; the plant is either stationary or on a movable barge or pontoon.

In addition to the Recent and Pleistocene superficial deposits, there are in the Tingha-Inverell district Eocene alluvials of similar origin and containing cassiterite derived from the same granitic rocks. These old valley deposits,

known as "deep leads," were buried beneath sheets of basaltic lava, which was accompanied by volcanic ash now altered to bauxite. The Elsmore Valley Lead is an example; there are three beds of wash-dirt, $10\frac{1}{2}$, $1\frac{1}{2}$, and 1 ft. thick, which are worked by a mine 225 ft. deep. The Newstead Lead was worked from its outcrop, and found to deepen gradually northward to a depth of 130 ft. or more.

Near the junction of Cope's Creek with the Gwydir River there are several hills of basalt overlying a Tertiary stream-deposit. This is worked for diamonds, which are small but numerous and are accompanied by topaz, sapphire, zircon, tourmaline, ilmenite, magnetite, spinel, cassiterite, etc. Although the tin is not in sufficient quantity to pay the whole cost of extraction, it forms a valuable by-product of the diamond-washing.

The Emmaville or Vegetable Creek district is some 40 miles to the north-east of Inverell and Tingha. The geological conditions are similar in the two districts. The oldest sedimentary rocks at Emmaville are bluish-grey claystones of Carboniferous age, which have been intruded by tin-bearing granite and by quartz felsites and diorites. There are Tertiary alluvial deposits and sheets of lava and volcanic ash, and finally Post-Tertiary stream-deposits.

Of the last type, the most productive was that of Vegetable Creek. The upper five miles of this stream are said to have yielded 15,000 tons of cassiterite between 1872 and 1884, the area worked being about 150 acres and the average depth of gravel washed about 2 ft. 6 in. Catarrh Creek also contained important shallow alluvial deposits, and there are numerous smaller occurrences in the district.

Of the Tertiary alluvial deposits some are capped by lava and some are bare, the lava having been removed by denudation. The most important deposit of the latter class is at the Y Water-holes. It has an area of 1,100 acres, and its depth averages about 20 ft. The deposit consists of current-bedded clay and sand, the richest ore occurring in the lower part and the next richest at the top, where the tin from denuded material has been concentrated. Scrubby Gully, Surface Hill, and Ruby Hill are other examples of bare Tertiary deposits.

Of the basalt-covered Tertiary leads in the Emmaville district, by far the most important is the Vegetable Creek Lead. In portions of its course there were two distinct flows of lava, each overlying a bed of stanniferous wash-dirt. The old stream had two main tributaries, giving rise to the Rose Valley Lead and Fox's Deep Lead. The latter, at its junction with the Vegetable Creek Lead, was struck at $247\frac{1}{2}$ ft. from the surface, and is the deepest lead worked in the Emmaville district. At Bailey's Mine, Rose Valley, a stanniferous alluvial deposit is overlain by a felspar porphyry, the only known instance in Australia of a deep lead beneath an acid lava.

To the south of Vegetable Creek Lead is the Graveyard Lead, and the two leads probably unite about six miles west of Emmaville. From this point a strip of basalt-covered country runs northward to Kangaroo Flat and Avoca, where stanniferous drift has been worked, and it is probable that the lead will be found rich enough to be worked in intermediate localities.

Farther west are the Spring Lead, Rocky Creek Lead, and Ruby Hill Lead, and to the east is the Wellington Vale Lead, near Deepwater.

Lode-mining for tin has been carried on in the Inverell and Emmaville districts. The lodes include fissure veins, joint veins, pipe veins and stockworks, and occur chiefly in granite. The associated minerals occurring in different veins are quartz, felspar, chlorite, mica, mispickel, pyrite, fluorite, tourmaline, wolframite, sphalerite, galena, chalcopyrite, bismuth, molybdenite, vesuvianite, stilbite, hæmatite, pyrrhotite, manganese, scheelite and beryl. The ore in most of the veins shows a tendency to run in shoots inclined to the plane of the lode. The largest veins now worked are the Ottery, Dutchman, Butler's and Curnow's veins, all of which are from 3 to 4 ft. wide. Pipe veins are a peculiar feature of both the Inverell and Emmaville districts. They usually occur in granite, and are circular or oval in section, and up to 4 or 5 ft. in diameter. They consist of quartz, felspar and chlorite, with disseminated cassiterite, molybdenite, wolframite, etc., and pass gradually into unaltered country-rock.

Still farther to the north-east is the Wilson's Downfall district, which may be regarded as an eastward extension of the Stanthorpe tin field of Queensland. Shallow alluvial deposits have been worked in the Ruby, Maryland, Herding Yard, Cemetery, Wilson's Downfall, Wylie, Two-Mile, and Bookookoorara Creeks.

In the Barrier district, in the extreme west of New South Wales, tin occurs at Euriowie and Poolamacca. At Euriowie cassiterite is found in coarsely crystalline dykes of granite and greisen traversing gneiss and mica-schist. The dykes are usually from one to twenty feet thick and terminate abruptly with rounded ends. Work in this field has been greatly hampered by scarcity of water and distance from any railway.

In the central portion of the State, tin ore has been found in the valley of the Lachlan, at Burra Burra, Mount Tallabong, Mandamah, Ardlethan and elsewhere, mostly as stream tin, but also in veins.

In the south, the Albury, Germanton, Tumbarumba and Wagga Wagga mining divisions produce some tin.

Small quantities of finely-divided cassiterite, associated with zircon, garnet, ilmenite, monazite, gold and platinum, occur in some of the shore-sands, notably between Byron Bay and Clarence Head, and in lesser quantities between Port Macquarie and Cape Hawke, near Seal Rocks, and at Shellharbour, Termeil, etc.

Stannite occurs in considerable quantity at Howell and Tolwong. Native tin has been recorded in the Aberfoil and Sam rivers, near Oban.

Victoria

The tin production of Victoria is very small, amounting to 48 tons in 1912. It is derived from lode and alluvial mining, mainly on the Mitta Mitta River and other localities in the Beechworth district. At Tallandoon, cassiterite is obtained from dykes of pegmatite and greisen intrusive in schists. Stream tin occurs at Mount Wills, Beechworth, Eldorado, Chiltern, Stanley, Coetong and Cudgema in the north-eastern district; Tin Creek and

Agnes River in Southern Gippsland; near Bruthen in Eastern Gippsland; at Gembrook, Neerim, Darnum, the Bunyip and Tarago Rivers in Western Gippsland; Upper Yarra, and other districts.

Tasmania

The principal tin mines of Tasmania are the Mount Bischoff, in the north-west of the island, and the Briseis and Pioneer mines in the north-east. These three mines produced 1,110, 539, and 468 tons respectively in 1912, and together accounted for 57 per cent. of the Tasmanian output. All the tin ore produced is smelted at Launceston.

Cassiterite was first discovered at Mount Bischoff in December 1871. The mine is situated on the top of the mountain, 3,500 ft. above sea-level and 45 miles from the north coast at Emu Bay. Mount Bischoff consists of contorted slaty rocks traversed by dykes of topaz and quartz porphyry, while the surrounding plains are largely formed by sheets of basalt. The porphyry dykes carry topaz and cassiterite, and there are fissure-veins containing cassiterite, pyrite, arsenopyrite, fluorite, wolframite, tourmaline and siderite. There are also detrital deposits formed by the disintegration of the lodes.

The Briseis mine, discovered in 1872, operates a deep lead near the Ringarooma River. The cassiterite occurs throughout the drift, which is a coarse quartz sand and is covered by a sheet of olivine-basalt. This is for the most part decomposed and can be removed by hydraulic operations. The local water supply being insufficient, a race has been constructed to bring water from a distance of over thirty miles. At the Pioneer mine, lower down the Ringarooma River, the lead is in places covered by 40 ft. of cemented material which has to be blasted.

At the Anchor and other mines in the Blue Tier district a tin-bearing granite is worked. When the whole of the stone is crushed it averages about ½ per cent. cassiterite, but richer patches occur. The ordinary granite of the Blue Tier consists of quartz, felspar, biotite and a little muscovite. In the tin-bearing granite, muscovite and talc

replace the biotite, the felspar is frequently kaolinised, and there is the addition of cassiterite, wolframite, scheelite, fluorite, pyrite, molybdenite, galena and chalcopyrite.

Farther south, in the Ben Lomond and Avoca districts, tin lodes occur in granite which is overlain by Permo-Carboniferous grits and conglomerates. These contain water-worn fragments of the granite and of quartz and cassiterite, and constitute one of the most ancient deposits of alluvial tin hitherto recorded. Veins of wolframite and cassiterite occur in the Scamander district.

In the west of Tasmania, south of Mount Bischoff, is the North Dundas tin field, including the Renison Bell, Boulder, and Montana mines. Here the tin-bearing veins have a complex structure and are of two types, in one of which cassiterite is associated with quartz and tourmaline, in the other with sulphides. The latter type is the more important. Pyrrhotite is the dominant sulphide, though pyrite is sometimes abundant. Arsenopyrite and chalcopyrite are often abundant, and there is usually a certain amount of galena, sphalerite and bismuthinite, as well as wolframite. Stannite has been observed. The gangue minerals are quartz and dolomite with smaller amounts of tourmaline, chlorite, epidote and fluorite. The greater part of the tin ore hitherto produced has been won from the gossans arising from the oxidation of the sulphide lodes, the remainder from residual and alluvial drifts and the quartz-tourmaline-cassiterite lodes.

Immediately to the east of the North Dundas field, in the X River district, the same two types of lodes occur, but there are indications that they merge into one another.

In the Zeehan field, nearer the west coast, a variety of veins occur, only some of which carry tin. The metal is present as cassiterite associated with quartz, pyrite and tourmaline, and as stannite associated with pyrite, chalcopyrite, quartz, siderite, fluorite, bismuthinite, tetrahedrite, wolframite and galena.

In the Heemskirk district cassiterite occurs in the surface soil and rubble, and has been traced to the parent lodes. The country rock consists of Silurian sandstones and slate, with a granite outcrop in the vicinity.

Western Australia

In Western Australia, tin has been produced in considerable amounts only in the Greenbushes district and the Pilbara gold field, but it is known to occur also in the Kimberley district, the Thomas River in the Gascoyne valley, the Murchison and Coolgardie. The greater part of the output is stream tin.

The Greenbushes district is in the south-west of the State. Cassiterite occurs in pegmatite and quartz-tourmaline veins and impregnations in granite. This is covered by lateritic alteration products, which in places contain concentrated residual tin ore. This material usually requires crushing. More important sources of tin are the alluvial deposits in the stream valleys. The richest of these is in Spring Gully, where an upper layer of sand, known as "free dirt," rests on stiff white "clayey dirt." The former is particularly rich in tinstone. Tantalite and stibio-tantalite occur with the cassiterite in some of these deposits.

About twelve miles south of Greenbushes, tin ore has been obtained at Nannup or Smithfield.

In the Pilbara district, in the north-west division, tin ore is produced at Moolyella, Cooglegong, Old Shaw (Eley's Well), Green's Well, Wodgina, Stannum, and Mill's Find. At all these localities the source of the cassiterite is the pegmatite veins which traverse granite and hornblende schist. At Wodgina, where, unlike most other tin fields in the State, the output of lode tin has exceeded that of stream tin, the lodes vary from mere threads up to a width of 500 ft. or more, and carry tourmaline and tantalite. At Moolyella the pegmatite veins consist largely of albite. From these sources are derived the shallow alluvial and residual deposits which, in most localities, have yielded the greater part of the tin produced. Tantalite, monazite, gadolinite and euxenite are occasionally found with the cassiterite in these deposits.

Northern Territory

Many tin-bearing areas are known to occur in the Northern Territory, and Chinese miners have produced a

considerable amount of tin, but systematic work by modern methods has been neglected. At Mount Wells, however, lode-mining is carried on. West Arm and Bynoe Harbour also yield tin ore, and the mineral is known to occur at Horseshoe Creek, Burrundie, Maranboy, Umbrawarra, and Mount Shoobridge, where two small lodes were formerly worked. The discovery of tin-bearing lodes at Beswick Creek has recently been announced.

Union of South Africa

The only districts in the Union of South Africa producing tin ore in any considerable amount are situated in the north-western part of the Transvaal and in Swaziland. The total output of ore for 1912 was as follows:

	Quantity. *tons.*	Value. £
Transvaal	2,618	367,699
Swaziland	385	37,946
Cape Province, Natal, Orange Free State	nil.	nil.
Total for the Union of South Africa	3,003	405,645

The Cape Province produced 161 tons of ore in 1907, 44 in 1908, 27 in 1909, 18 in 1910, and 7 in 1911.

Transvaal

The Waterberg tin fields in north-western Transvaal include the Potgietersrust tin field (Zaaiplaats, Roodepoort, Groenfontein, Solomon's Temple, etc.), the Nylstroom tin field (Doornhoek, Kromkloof, Welgevonden), the Warmbaths tin field (Zwartkloof, Elandsfontein, Witfontein, etc.), and the Rooiberg tin field. All these localities lie on the eastern and southern margins of a geological basin, the central portion of which is composed of sandstones and conglomerates of Upper Waterberg age, constituting the Waterberg plateau. Below the escarpment of these beds is a belt of Lower Waterberg felsites with interbedded shales, and quartzites in the Rooiberg, overlying the Red Granite and the Norite of the Bushveld Plutonic Complex. Beyond the outcrop of these lie the Older Granite and the quartzites and dolomites of

the Transvaal System. These older rocks, however, are unconnected with the source of the tinstone, and the same may be said of the Karroo beds which overstep all these formations in the south-eastern part of the district. The Red Granite and the Lower Waterberg rocks are the important tin-bearing formations. In the Red Granite the cassiterite deposits occur—(*a*) in the form of roughly cylindrical pipes; (*b*) associated with irregular bodies of altered granite; (*c*) as irregular disseminations in slightly altered granite; (*d*) as impregnations along well-defined lines of fissure; (*e*) associated with pegmatite and quartz veins. In the felsites, shales and quartzites of the Lower Waterberg the deposits are found (*a*) in lodes and more or less definite lines of fissure, small veins and leaders, and (*b*) as irregular patches and pockets, often connected with fissures or determined by planes of stratification.

The most important deposits in the Potgietersrust tin field are situated on the farms Zaaiplaats, Roodepoort, Groenfontein and Solomon's Temple. They are distributed along a well-defined zone in the Red Granite, which strikes in a north-west and south-east direction and continues into Groenvlei and Appingadam in one direction and Welgevonden, Welgelegen, and Grootrivier in the other. This zone comes immediately below a coarse pegmatite. The usual type of deposit in this field is that of cassiterite-bearing pipes, roughly circular in section, descending at varying angles into the granite in a general north-westerly direction. They vary from two to twelve feet in diameter, and two of them have been proved to a depth of over 400 ft. on the incline. They usually occur in groups, and neighbouring pipes may unite either at depth or near the surface. The pipes sometimes show an outer zone of tourmaline-quartz rock, which is usually not more than a few inches thick. The main mass of the pipe varies from slightly altered granite to an apparently homogeneous greenish material which sometimes becomes extremely hard through secondary silicification. In the smaller pipes the cassiterite is fairly uniformly distributed, but in the larger ones it is generally more concentrated towards the periphery, and especially the lower portion,

while in the central portion it is less abundant or even absent. Cavities or vughs occur in some of the pipes; they are lined with quartz crystals and contain also fluorite, galena, sphalerite, and arsenical and copper pyrites. In addition to the pipes, several other types of ore body are found, some of which show a flat and more or less lenticular form. In one case there are several sheets of tin-bearing granite separated by barren rock. Fissure veins and irregular masses of altered tin-bearing granite also occur.

The Nylstroom tin field is situated on the farms Doornhoek, Kromkloof, and Welgevonden, some sixteen miles north-east of Nylstroom. The principal deposits are associated with the felsites and shales of the Lower Waterberg. The main lode at Doornhoek cuts the bedding-planes of the shales obliquely; it averages 18 in. in width, and is largely made up of brecciated and highly altered fragments of the country rock, with quartz, tourmaline, cassiterite and fluorite. A second lode follows one of the coarser beds in the shales, which also is much altered and brecciated. In the immediate neighbourhood of these lodes the shales sometimes show minute veins of cassiterite. A short distance below the base of the shales the underlying felsites carry cassiterite, associated with quartz and hæmatite, in small pockets from a half to one and a half inches in diameter, while other pockets contain tourmaline with quartz and sericitic matter.

The Warmbaths tin field extends from Zwartkloof through Droogekloof, Elandsfontein and Newbury to Witfontein and thence northward to Rhenosterpoort, forming a narrow belt which follows the junction of the felsites and the Red Granite. Cassiterite occurs in both types of rock, and there are also alluvial deposits. At Zwartkloof the ore bodies are somewhat irregular and ill-defined; they occur in the granite and are frequently associated with masses and veins of very coarse pegmatite and quartz. Alluvial and eluvial deposits occur on this farm. On Elandsfontein No. 1,782, there are two main sets of fissures in the granite, and the ore bodies associated with them vary in width from a few inches to two or three

feet. Fissure lodes also occur in the lower part of the felsites. On Witfontein No. 371, the alluvial deposits have proved more important than the occurrences in the granite and felsite. All three types of deposit occur also on Elandsfontein No. 2,149, and small quantities of tin have been won from the granite on Rhenosterpoort.

The Rooiberg tin field lies about forty miles west of Warmbaths. The cassiterite deposits, with the exception of one occurrence in the Red Granite, are all found in the Rooiberg quartzites, which, with the associated shales, are overlain with apparent conformity by the Lower Waterberg felsites, while both types of rock are intruded by the Red Granite. The workings are principally on the farms Olievenbosch and Hartebeestfontein, but also on Weynek, Quaggafontein, and Leeuwpoort, and many of them are on the site of ancient workings. The lodes in the quartzites coincide with two main sets of fissures, and there are also irregular pockets of mineralised rock rich in tourmaline and cassiterite. Other minerals frequently present are quartz, carbonates of iron and lime, felspar, hæmatite, pyrite and chalcopyrite. Superficial deposits of limonitic breccia, known as "ou-klip," are occasionally rich in tin. On Quaggafontein, cassiterite occurs in the upper portion of the Red Granite.

In the Bushveld tin field, forty miles north-east of Pretoria, cassiterite occurs in the Red Granite on the farms of Enkeldorn and Vlaklaagte.

Swaziland

In north-western Swaziland there are two tin-bearing districts, viz. the alluvial deposits of Embabaan and the surrounding country, and the lodes round Forbes Reef on the east side of the Ingwenya Range.

The alluvial deposits occur as "flats" along the course of the Babaan and other rivers. At King's Flat, to take a typical example, there is a soft overburden of about 12 ft. of dark soil, which carries little tin. Below this lies 2½ ft. of coarse tin-bearing gravel, composed largely of fragments of quartz up to 3 in. across, which rests on the granite floor of the valley. The cassiterite occurs

in the gravel as loose crystals, but occasionally in boulders of pegmatitic rock; it is associated with other accessory minerals of the granite, including monazite, euxenite, æschynite, corundum and tourmaline. Although no definite lodes have been found, there is little doubt that the cassiterite is derived from the granite which forms the surrounding country, and which has been identified with the Older Granite rather than the Red Granite of the Waterberg tin fields. There is an abundant rainfall and the conditions are favourable to hydraulic sluicing.

Forbes Reef is situated some fourteen miles north of Embabaan on the east side of the Ingwenya Range. This range is formed of quartzites and schists of the Swaziland System, which are intruded by the same granite as at Embabaan. In one case the tin occurs in a dyke in the schist, 2 to 3 ft. wide, composed almost entirely of white felspar with patches of chlorite and cassiterite. More usually the veins follow fissures parallel to the strike of the schists. Along these fissures the schist is tin-bearing over a width of about 3 in.

Cape Province

At Kuils River, about sixteen miles from Cape Town, tin-bearing lodes occur in a grey granite. Alluvial tin occurs in a creek on the farm Langverwacht, twelve miles from Cape Town. At Vredehoek, also near Cape Town, a series of small flat tin-bearing veins occurs in slates and quartzites of the Malmesbury Series, not far from a granite outcrop.

Southern Rhodesia

The Victoria tin field is situated between thirty and forty miles east of Victoria, and some fifteen miles N.N.W. of Ndanga. It consists of an area of metamorphic rocks bounded on three sides by a grey biotite granite. Pegmatite dykes and sills are found along the margins of the granite, and are also intruded into the metamorphic rocks at some distance from the granite. The latter dykes and sills are more or less altered to greisen and carry cassiterite. In the report of the local Geological Survey

for 1911 it is stated that there is a possibility of fairly large low-grade bodies being proved profitable to work.

The discovery of a tin lode has been reported on the site of ancient workings in the Hartley district some 180 miles from Buluwayo.

Nigeria

The principal tin fields of West Africa lie in the western part of Bauchi Province, near the centre of the Northern Provinces, Nigeria. The ore was washed and smelted by natives long before the advent of Europeans, and it is probable that the occurrences of "native tin" reported in the stream deposits are of artificial origin. Practically all the Nigerian tin now being produced is from alluvial deposits, where it is usually accompanied by small amounts of monazite.

The most important workings are on the Bauchi plateau, in the neighbourhood of Naraguta, Jos, Ngell, and Bukuru. The elevation is from three to four thousand feet above sea-level, and the climate is good. The alluvial cassiterite is derived from veins and impregnations in a soda granite intrusive in ancient crystalline rocks. Similar granite occurs in the Kwandokaya Hills to the north of Toro and in the Ningi Hills, and in each case carries tinstone. In the neighbourhood of Ngell, pyrite, chalcopyrite, tetrahedrite, sphalerite and galena are also present.

Cassiterite occurs in small quantities in the neighbourhood of Gadama and Fagam, on the borders of Bauchi and Kano, around Gantam and Aribi on the Nassarawa tableland, on the eastern slopes of the Vere Hills in Yola, and the western slopes of the Shebshi Hills in southern Muri, and in the neighbourhood of Eri in eastern Ilorin. In the last locality the mineral occurs in a pegmatite vein.

In the eastern part of the Southern Provinces, Nigeria, cassiterite occurs in the stream deposits near Akwa-Ibami, Uwet district, the average amount being 3 lb. per ton (see *Reports on the Mineral Survey of Southern Nigeria* for 1903–4 and 1904–5 [Cd. 2876], p. 22), while smaller amounts have been found in many other localities both in the Southern and Northern Provinces, Nigeria (*loc. cit.* and *Reports on*

the Mineral Survey of Northern Nigeria [Cd. 2875, 1906], [Cd. 3914, 1908], [Cd. 3915, 1908], [Cd. 4719, 1909], and [Cd. 5899, 1911].

The output of Nigerian tin ore in 1912 was 2,803 tons, valued at £336,330.

THE TRADE IN PALM KERNELS

THE two chief products obtained from the West African oil palm are palm oil and palm kernels. The former is obtained from the pericarp or outer pulpy layer of the date-like fruit of the oil palm, whilst the kernels are secured by shelling the palm nuts, which are obtained when the pericarp is removed from the fruit.

Of these two products palm oil has always occupied a very important place in the commerce between the United Kingdom and its West African possessions, but the commerce in palm kernels has until the last few years been left entirely to Germany, which has thus secured practically a monopoly of a very valuable trade and of the industries which depend on it. The technical features of the West African palm oil industry have been fully discussed in two long articles published in previous numbers of this BULLETIN (1909, **7**, 357; 1913, **11**, 206), and the reader may be referred to them for general information on the whole subject. In the present article it is merely proposed to call attention to the magnitude of the trade in palm kernels and to the desirability of British merchants and manufacturers using the opportunity afforded by the European war of securing a large proportion of this trade for this country. The quantities and values of the exports of palm kernels in 1912 from each of the chief producing countries in West Africa is shown in the following table :

	Quantities. *Tons.*	Values. £
British Possessions :		
Gambia	445	6,518
Gold Coast	14,629	205,365
Nigeria	184,624	2,797,411
Sierra Leone	50,751	793,178

	Quantities. *Tons.*	Values. £
French Possessions :		
Dahomey	36,708	535,937
Gaboon	354	4,671
Guinea	5,054	41,079
Ivory Coast	6,692	70,710
Senegal	1,736	28,221
Belgian Congo	—	110,835
German Possessions :		
Kamerun [1]	15,742	220,300
Togoland [2]	11,456	168,978
Liberia and Portuguese West Africa. Recent figures not available.		

[1] *Duala, the capital of Kamerun, was occupied by an Anglo-French force on September 27 last.*

[2] *Togoland was occupied by an Anglo-French force on August 7 last.*

These figures are sufficient to indicate the importance and value of this trade. The following table, giving the distribution of the exports of palm kernels from the British Possessions in West Africa during the period 1910–12, shows that practically the whole of this trade is in the hands of Germany.

Exports of Palm Kernels from British West Africa

Nigeria

	1910.		1911.		1912.	
	Tons.	£	*Tons.*	£	*Tons.*	£
United Kingdom	22,156	300,157	22,884	318,943	25,491	365,461
Germany	143,966	2,071,574	145,783	2,166,106	140,036	2,175,736
Holland	6,876	79,083	7,503	86,290	14,433	181,639
South Africa	—	—	219	3,066	4,664	74,575
Total	172,998	2,450,814	176,389	2,574,405	184,624	2,797,411

Sierra Leone

	1910.		1911.		1912.	
	Tons.	£	*Tons.*	£	*Tons.*	£
United Kingdom	4,652	71,083	9,654	149,433	8,846	140,963
Germany	38,297	572,369	33,238	507,915	41,904	652,210
Other countries	82	1,232	—	—	½	5
Total	43,031	644,684	42,892	657,348	50,751	793,178

Gold Coast

	1910.		1911.		1912.	
	Tons.	£	*Tons.*	£	*Tons.*	£
United Kingdom .	2,667	34,898	2,430	30,967	2,772	37,548
Germany . .	11,286	146,989	10,110	135,187	11,079	157,322
France . . .	299	3,171	714	9,736	768	10,370
Other countries .	—	—	—	—	10	125
Total . .	14,252	185,058	13,254	175,890	14,629	205,365

Gambia

	1910.		1911.		1912.	
	Tons.	£	*Tons.*	£	*Tons.*	£
United Kingdom .	467	5,640	443	4,756	445	6,518

Almost the whole of the palm kernels imported into Germany are received through Hamburg, and consequently the following table, showing the imports to Hamburg in each of the last three years, gives a good idea of the value of this trade to Germany.

Imports of Palm Kernels to Hamburg

	Tons.	£
1911 . . .	262,680	4,789,590
1912 . . .	283,536	5,263,274
1913 . . .	241,961	5,233,252

Uses and Value of Palm Kernels

Palm kernels are used in Germany as a source of oil (palm-kernel oil) and feeding-cake (palm-kernel cake). The average value of the kernels in Hamburg ranges from £18 2*s.* to £19 2*s.* per ton (June 1914); the value in Liverpool was £17 17*s.* 6*d.* to £18 18*s.* 9*d.* per ton in July last, and is now £16 7*s.* 6*d.* to £17 10*s.* per ton (September 1914).

Palm-kernel Oil

The quantity of oil yielded by the kernels varies from 46 to 53 per cent. Practically all the palm-kernel oil of commerce is expressed in Europe, the chief centre being Harburg, near Hamburg, though some is expressed in

Liverpool. Attempts have been made to express the oil on a large scale in West Africa, but these have not proved altogether successful. The natives prepare small quantities of palm-kernel oil by crude methods, but this is entirely for their own use.

On the commercial scale palm-kernel oil is obtained either by extraction with solvents or by expression. In the latter case, the crushed kernels must be pressed twice on account of the large amount of fat contained in them. The first expression is usually carried out at a temperature of 45–50° C., and the second at 55°–60° C. By this means about 43–45 per cent. of palm-kernel oil is obtained, corresponding to a yield of about 1,000 lb. of oil per ton of palm kernels. By extraction with solvents the whole amount of oil or any desired proportion of it can be recovered at will; but if all the oil is taken out the residual meal is less valuable as a feeding-stuff, and in addition it is frequently asserted that the cake is then unsuitable for use as a feeding-stuff, and that the oil obtained is not of edible quality. It is, however, fairly certain that with proper care and the use of suitable solvents the residual meal can be obtained suitable for feeding purposes and an oil of edible quality prepared by extraction processes (*see below*).

Palm-kernel oil at European temperatures is a white or pale-yellow solid fat possessing a pleasant nutty taste. It closely resembles coconut oil in appearance and properties. The following table gives the range of the principal constants of commercial palm-kernel oil. The corresponding figures for coconut oil are added for comparison.

	Commercial palm-kernel oil.	Coconut oil.
Specific gravity at $\frac{99° C.}{15° C.}$	0·873	0·874
Iodine value . . *per cent.*	10·3–17·5	8·0–10·0
Saponification value	242–255	246–268
Titer test	20·0° C.–25·5° C.	21·2° C.–25·2° C.
Hehner value	91·1	82·4–90·5
Reichert-Meissl value	5·0–6·8	6·6–7·5
Polenske value	—	18·0
Yield of oil	46·7–52·5	64·5–74·7

Palm-kernel oil is used for the same purposes as coconut oil, viz. the manufacture of soap and candles and the preparation of various edible fats, such as margarine, cooking fats, vegetable "butters," and chocolate fats. By suitable treatment it can be separated into a liquid portion (olein) and a hard white fat (palm-kernel stearin), and in this way the consistence of the material can be varied for the preparation of different edible products. These edible palm-kernel oil products are prepared on a very large scale in Germany and elsewhere, and are largely imported into this country. With palm kernels at £17 to £18 per ton the value of palm-kernel oil in the United Kingdom is from £36 5*s*. to £36 15*s*. per ton with Ceylon coconut oil at £40 per ton.

Palm-kernel Meal

The meal which is left, after expression or extraction of the oil from palm kernels, is of value as a cattle food. The cake has not a very pronounced flavour and is usually fed in the dry state. In Germany it finds a good sale, especially as a food for young pigs, and, like coconut cake, it is said to improve the fat content of the milk when fed to cows. On this latter point Mr. E. W. Thompson, Commercial Agent of the Department of Commerce of the United States, who has recently investigated the possibility of increasing the market for American cotton-seed meal in Germany, says, "Palm-kernel meal from the local (German) mills has made a fine reputation as a milch-cow feed and sells itself." On the question of the suitability of palm-kernel meal prepared by extraction processes for feeding purposes the same author says, "Palm kernels are largely worked by the solvent process, delivering meals with about 19 per cent. protein and 2 per cent. fat as compared with 18 per cent. protein and 8 per cent. fat for meal from hydraulic presses. The digestibility of the solvent meal (known in Germany under the general name 'schrot') is more satisfactory than the other—80 per cent. against 73."

The following table gives the composition and current

value of palm-kernel cake in comparison with coconut, linseed, and cotton-seed cakes :

Name of Cake.	Composition, *per cent.*						Current Value, *per ton.*
	Moisture.	Crude protein.	Fat.	Carbohydrates (by difference).	Crude fibre.	Ash.	
Palm-kernel cake:							
(1) expressed	9·7	17·7	8·6	36·2	23·8	4·0	£6 8*s.* to £6 12*s.* (Hamburg, June 1914).
(2) extracted	10·9	18·7	1·6	39·1	25·4	4·3	—
Coconut cake (expressed)	10·5	21·4	8·5	38·7	14·7	6·2	£7 8*s.* to £8 3*s.* (Hamburg, June 1914).
Linseed cake:							
(1) expressed	11·0	33·5	8·6	31·7	8·7	6·5	English, guaranteed 95 per cent. linseed, £8 12*s.* 6*d.* to £8 17*s.* 6*d.* (Hull, September 1914).
(2) extracted	10·2	37·4	3·8	32·7	9·1	6·8	—
Cotton-seed cake:							
(1) decorticated	8·0	46·2	8·9	22·9	7·0	7·0	English, £9 5*s.* to £9 7*s.* 6*d.*
(2) undecorticated (both expressed)	10·5	24·5	6·5	26·3	25·0	7·2	English, £6 5*s.* to £6 7*s.* 6*d.* (Liverpool, Sept. 1914).

The Market for Palm-kernel Oil and Meal

A considerable proportion of the palm-kernel oil produced in Germany is exported either as such or in the form of prepared edible and other fats, but practically the whole of the palm-kernel cake or meal made is consumed in the country itself, the consumption in 1912 amounting to 120,000 out of a total of 138,816 metric tons produced (E. W. Thompson).

In the event of the palm kernels now exported to Germany from British West Africa being diverted to this country, British oil-seed crushers who undertook to work them would find no difficulty in getting a market for the oil among soap-makers and makers of edible fats in this country. There might, however, be some difficulty in finding a market quickly in this country for the palm-kernel cake, owing to the fact that English farmers are extremely conservative and do not readily take up feeding-stuffs which are new to them. It is stated, for example, that this very conservative attitude of the English farmer is largely responsible for the decline in the imports of soya beans to the United Kingdom in the last year or two, owing

to the fact that it proved impossible to create a large market in this country for soya cake, although it rapidly became popular in Germany.

The manufacturer of palm-kernel cake in the United Kingdom would therefore probably have to depend largely at first on the makers of compound cakes to absorb his produce, but in face of the abundant German evidence of the high feeding value of palm-kernel cake it should not be difficult for the manufacturer to popularise gradually this material among farmers and cattle keepers in the United Kingdom.

There is room for an enormous extension of the production of feeding-cakes in the United Kingdom, since no less than 406,700 tons of such cakes, valued at £2,539,892, were imported, chiefly from foreign countries, in 1913. The imports are principally cotton-seed, linseed, and rape-seed cakes.

TRADE AND INDUSTRIES OF SEYCHELLES

A copy of the Report of the Collector of Customs on the Trade of Seychelles for 1913 has been received recently, and as it is of considerable interest as indicating the present state of the agricultural and other industries of the Colony, the Colonial Office has sanctioned the publication of the following summary of its contents. Previous articles dealing with the trade and agricultural products of Seychelles will be found in this Bulletin (1904, **2**, 269; 1908, **6**, 107; 1909, **7**, 262, 394; 1910, **8**, 413; 1911, **9**, 280; and 1912, **10**, 120).

The total value of the imports in 1913 was Rs. 1,279,942 (R. 1 = 1*s.* 4*d.*), as compared with Rs. 1,176,511 in the previous year. The more important items were as follows: Foodstuffs, chiefly from India, Rs. 518,719; cotton goods, mainly from the United Kingdom, India, and France, Rs. 203,305; spirits, wine, and beer, Rs. 90,029; sugar, entirely from Mauritius, 343,028 kilograms, valued at Rs. 58,350; haberdashery, Rs. 48,865; hardware and iron-ware, Rs. 45,177; machinery, Rs. 33,880, an increase of Rs. 26,217 as compared with 1912, due to the importation

of plant for the distillation of essential oils; soap, almost entirely from the United Kingdom, Rs. 19,290; boots and shoes, Rs. 17,752; kerosene, from America and South Africa, Rs. 13,917; tobacco, chiefly from Réunion, United Kingdom, and Holland, Rs. 11,298.

The total value of the exports in 1913 amounted to Rs. 2,484,202, being a net increase of Rs. 727,154 over the previous year, and the highest value on record. The commodities which show increases include copra, guano, caret (tortoise) shells, essential oils, rubber, salted fish, coir, and turtle bones. The following products show decreases: vanilla, cinnamon bark, coconut oil, soap, coconuts, whale oil, calipee, and coco de mer. The principal exports in 1912 and 1913, and the countries of destination in the latter year, are shown in the following table:

	Quantity.			Value.		Country of destination in 1913.
	Unit.	1912.	1913.	1912.	1913.	
				Rs.	Rs.	
Copra .	cwts.	53,844	58,865	801,196	1,080,736	France, United Kingdom, Germany, Belgium.
Guano .	cwts.	310,260	694,400	465,414	1,041,600	Chiefly to Belgium, United Kingdom, Holland, and New Zealand.
Vanilla .	cwts.	157	120	151,331	101,847	Chiefly to United Kingdom.
Caret shells	—	—	—	35,025	63,633	France, United Kingdom, and Germany.
Cinnamon bark .	cwts.	22,205	13,962	93,305	53,305	Not given.
Coconut oil	gallons	13,426	10,697	32,381	25,604	Not given.
Soap . .	cwts.	2,365	1,271	43,800	23,288	Chiefly to German and French Colonies.
Calipee .	cwts.	315	123	28,547	16,501	United Kingdom.
Essential oils .	gallons	506	924	7,700	16,482	France, Germany, and United Kingdom.
Salted fish	—	—	—	6,949	7,422	Largely to Réunion.
Coconuts .	number	182,327	103,350	9,912	5,473	Madagascar, Aden, France, Mauritius, and South Africa.
Whale oil .	gallons	23,659	4,622	48,000	4,542	United Kingdom.
Rubber .	lb.	677	1,768	2,265	4,165	United Kingdom.
Boats and accessories	—	—	—	7,150	13,975	Madagascar.

Other items of export in 1913 in order of value were coco de mer (Rs. 2,846), turtle bones (Rs. 1,350), hides (Rs. 1,235), trepangs (Rs. 1,106), sharks' fins (Rs. 652),

green turtle shells (Rs. 443), vacoa mats (Rs. 410), citrate of lime (Rs. 354), and coir (Rs. 255).

It is interesting to note the considerable increase in the exports of copra, but this has been responsible for a decrease in the exports of coconuts and coconut oil, and the scarcity of the latter has led to a decline in the manufacture of soap.

The increase in the exports of guano is stated to be due to a more serious exploitation of the deposits in the Aldabra group of islands (cf. this BULLETIN, 1911, **9**, 39).

It will be seen that cinnamon bark shows a very considerable decline. This bark is obtained chiefly from trees felled in clearing new land, and is gradually diminishing in quantity, and it is thought that its export will eventually cease.

The essential-oil industry continues to increase in importance, and new distillation machinery has been installed. The exports comprise chiefly oils distilled from cinnamon leaves, clove leaves, and lemon grass.

An important addition to the industries of the Colony is that of whaling. A British whaling company started at Seychelles in August 1913 with one motor whaler. Under the Whale Fishery Ordinance (No. 11 of 1913), the licence duty is Rs. 300 per annum for one factory and one whaler. There is at present no restriction with regard to the killing of cows, but it is proposed to frame regulations in that direction with the object of checking this suicidal policy. The export duty on whale oil is R. 1 per 100 litres, and R. 1 per ton for whale manure. In previous years the waters of Seychelles have been periodically visited by United States whalers, the last occasion being in 1912, when oil to the value of Rs. 48,000 was shipped to the United States.

GENERAL NOTES

Cotton Cultivation in French Colonies.—At the annual meeting of the French Colonial Cotton Association in March 1914 a report was made on the results achieved during 1913, and this has been published in the *Bulletin de l'Association Cotonnière Coloniale* (1914, **12**, No. 60).

The Association has furnished supplies of cotton seed to Morocco. Samples of cotton have been received from Showia which lead to the belief that, when the pacification of the country has been completed and the means of transport improved, good crops will be produced in this part of Morocco. Several consignments of cotton from the Ujda region have been sold and greatly appreciated. The results obtained in Algeria were somewhat disappointing on account of the continuous drought. Good progress has been made in Dahomey, but the industry will not undergo great extension until the railway has opened up the northern parts of the Colony. Very promising results have been obtained in the Ivory Coast, and it is hoped that the efforts of the Administration will lead the natives to improve their methods of cultivation. Considerable advance has been made in parts of Oceania, and especially in New Caledonia. The total quantity of cotton produced under the auspices of the Association in 1913 amounted to 715,511 kilograms, as compared with 608,500 in 1912; this does not include the exports from Indo-China, which are not under the control of the Association. The following are the quantities (kilograms) produced in the various Colonies in 1912 and 1913:

	1912.	1913.
Senegal	20,000	7,723
Upper Senegal and Niger region	100,000	98,751
Dahomey	125,000	175,450
Ivory Coast	—	39,737
New Caledonia	165,000	258,030
Tahiti	15,000	15,820
Algeria	180,000	120,000
Madagascar	3,500	—
	608,500	715,511

Agricultural Development of Sumatra.—The state of chronic warfare in Achin, the northern part of Sumatra, was brought to a close about five years ago, and consequently the conditions for development and employment of capital greatly improved. This circumstance, and the profits anticipated from rubber growing attracted the attention of capitalists to the island, where there was much land to be acquired, and many coffee plantations could be bought and transformed into plantations of Hevea.

An account of recent progress in the island is given in *Agronomie Tropicale* (1914, **6**, Pt. ii, 47, 61), based largely on the reports of Belgian consuls. Sumatra is traversed lengthways by a range of mountains which is situated much nearer the west coast than the east; consequently the eastern side possesses land much better suited for plantations, and also has a network of navigable rivers. The Deli district on the east coast has long been well known for its tobacco, Plantations of this and of coffee caused its

rapid development, but until recently the rest of the island, with the exception of Padang on the west coast, was quite unprogressive. Now, however, plantations are being established in many other parts, a preference being given to situations on the rivers.

The products of the oil palm and of the coconut palm are among those being exploited, as mentioned on pp. 481, 483 of this BULLETIN. The hilly districts are suitable for tea cultivation, which has been commenced in the island and has good prospects, but in some parts the want of roads presents a difficulty. The tobacco industry has yielded enormous sums since it was first started in the island, and the yield in 1912, after deducting the cost of production, is estimated at about £3,000,000, nine-tenths of the production going to the Amsterdam market. As regards rubber, the Brazilian Commission which visited the East Indian islands, the Straits, and Ceylon in 1911–12 estimates that the area planted and ready to be planted with Hevea rose from 6,140 acres in 1906 to 220,000 in 1912, and that the capital employed was £10,420,000, the rubber boom being the cause of this great increase. The production was expected to be 8,000 tons in 1914, 12,000 tons in 1915, and to reach 44,000 tons in 1919, without taking into account trees planted after 1912. Generally speaking, the trees that the Commission saw were healthy and free from root-rot and the attacks of white ants, though here and there they had suffered by tempests. There is a considerable difference in the rainfall in different places, but it is everywhere sufficient. Owing to good soil, the trees can grow at altitudes up to 1,000 ft., but they are usually situated at altitudes between 4 ft. and 120 ft. The Assam rubber tree, *Ficus elastica*, is grown in the Benkoelen, Tapanoeli, and Achin provinces.

The chief hindrances to the development of the island are the lack of means of communication and the scarcity of labour; but the Government is going to take active steps to remedy the former of these, and to overcome the latter it has since 1905 been settling Javanese families on land prepared for them. The establishment of rice cultivation by means of irrigation on the west side, and especially in the Benkoelen province, is also contemplated. Some progress has been made in recent years in the island, but it is only small in comparison with the great possibilities of development offered by the vast amount of unoccupied land awaiting exploitation when capital, labour, and roads and railways are provided. Hope lies in the direction of an overflow of population from Java.

The report of the Belgian Consul at Medan for 1912 gives very full information about the East Coast Province of the island. Here tobacco growing, which dates from 1864, was the only cultivation up to 1890, and is still the most im-

portant. There are 99 plantations belonging to 36 companies and 2 private individuals. Some companies have given up tobacco growing for some time in favour of rubber; omitting these, the capital of the tobacco plantations is a little over £4,000,000; the area under tobacco in 1912 was about 50,000 acres, and the bales produced weighed about 21,600 tons; some of this tobacco fetched in Holland 2·29 florins per half kilogram (3*s.* 6*d.* per lb.).

Coffee cultivation is declining. Formerly Hevea was planted as an intercalary crop in the coffee fields, but now the reverse is the case, and the coffee trees will be eliminated as the Heveas become ready for tapping. Formerly Liberian coffee had the preference, but since 1908 Robusta has been preferred for planting with the Heveas. In 1911, 1,338 tons of coffee, almost entirely Liberian, were exported, whilst in 1912 only 693 tons were exported, of which 98 tons were Robusta and 13 tons Arabica, the rest being Liberian. Robusta coffee is preferred by the planter because it is productive after three years, whilst Liberian gives scarcely any harvest before the fifth or sixth year.

As in other places, the cultivation of rubber trees has made great advances since the beginning of the century; in 1902 there were only about 400 acres planted with Hevea, whilst at the end of 1912 the acreage had increased to 197,530. In addition to this the area planted with *Ficus elastica* (rambong) by European companies is estimated at 7,000 to 10,000 acres, and there are native plantations besides. The export of rubber in 1912 from the East Coast Province was 1,926 tons, of which 1,466 tons were Hevea rubber. The nominal capital concerned in the rubber plantations at the end of 1912 was £10,600,000, of which about half was British.

Tea growing was only introduced in 1910–11, being started by an English company in the district of Siantar at an altitude of 600 to 1,000 ft. Eight more plantations have since been made, and some new tea companies with English or Dutch capital have been formed.

Other cultivations of the Province are coconut palms, oil palms, gambier, tapioca, pepper, sago, and rice.

Toxic Action of Roots on Vegetative Growth.—The effect of growing grass above the roots of fruit and other trees has been under investigation since 1895 at the Woburn Experimental Fruit Farm (see this BULLETIN, 1912, **10**, 184), and has been found to be most injurious. If trees are planted, and if the ground is then grassed over, either by sowing or by replacing the turf, there is an arrest of all healthy growth, and the trees are stunted; in the case where well-established trees are grassed over the effect is not so immediate. An account of experiments to discover the cause is given in the *Journal of Agricultural Science* (1914,

6, 136). The effect varies with the nature of the soil and the plant; the nature of the grass does not make much difference, but the vigour of its growth has an influence. The stunting action is accompanied by other indications of starvation; the foliage and bark are of an unhealthy light colour, and there is a marked deficiency of green colouring matter in the fruit; these effects, however, are not caused by a deficiency of plant food or water in the soil.

Experiments were made in which trees and plants were grown in large pots; and perforated trays, in which grass or clover could be grown, were placed above the soil in these pots. In this way the drainage from the grass or clover in the trays percolated through to the roots of the plants growing in the pots. After a time, when in most cases those without grass were mature and fruiting, the plants were removed, dried at 100° C., and weighed, and it was found that those grown under grass or clover had not reached maturity, and weighed usually much less than those grown under bare soil. In some pots, however, the plants growing under grass were allowed to grow on and come to maturity; in these it was found that the plants weighed even more than those grown under bare soil.

The results led to the conclusion that a toxin must be produced by the grass or clover, which reaches the roots of the plants beneath, producing the ill-effects observed. The toxin is probably not an excretion from the plant, but results from the debris from the growing roots, or perhaps is the result of an alteration in the bacterial contents of the soil caused by the growth of the grass. In some experiments the grass was grown in trays away from trees, and the drainings, after having been exposed to the air for an hour or two, were applied to the trees; it was then found that the toxin seemed to have become oxidised, and that the drainings now caused increased growth instead of injury. This affords an explanation of the increased weight when the plants under grass were allowed time to make up for their retarded development and to attain maturity. The conclusion is that the effect of the toxin formed by the grass is eventually overpowered by the beneficial effect of some other substance formed, probably merely the oxidation product of the previously formed toxin itself. It is even possible that partial grassing might have a beneficial effect when the grass is at such a distance from the tree-roots that the toxin becomes oxidised before reaching the roots. Recovery from the toxic effect may not always occur, as the plant may be permanently injured; this is likely to occur with hard-wooded plants, which may become permanently stunted. Scarcely any instances of recovery from the grass effect have been noticed with fruit trees at the Experimental

Farm. In some experiments grass and clover were grown both in the trays and in the pots, with the result that the plants in the latter were greatly injured.

The final conclusions were: Every growing crop results in the formation of a substance which is toxic to the growth of other plants, and still more so to itself. By oxidation this toxin loses its toxic properties and enhances the fertility of the soil. The plants previously poisoned eventually outstrip those which have not been subjected to the poisoning, except in cases where the toxic effect has been sufficient to produce a permanent stunting. It has also been found that the heating of a soil produces toxic matter from the organic substances present in it, and in much greater quantities than that produced by the growth of a crop. In both cases the toxin, after oxidation, increases the fertility of the soil.

The Destruction of Locusts by Bacteria.—In 1910 M. F. H. d'Hérelle discovered a disease of locusts caused by a bacillus which he named *Coccobacillus acridiorum.* He found that the disease could be transmitted to healthy locusts by inoculating them with the bacillus, and that by successively inoculating about twelve series of insects the virulence of the disease increased so that the locusts were killed in about eight to ten hours. In order to ascertain whether the disease could be employed on a practical scale for the destruction of migratory locusts in the field M. d'Hérelle was commissioned by the Argentine Government to carry out experiments in that country. On January 16, 1912, a large number of locusts were enclosed in an area of just over an acre near Escalada, and the ground was sprayed with half-a-litre of a culture of a high degree of virulence. After four days 75 per cent. of the insects were dead, and all the rest which had contracted the disease succumbed in a further four days. The disease spread rapidly from the centre of infection, and at the end of two or three days was found about 27 miles away, and after eight days about 48 miles off. Equally satisfactory results were obtained when larger areas were sprayed. As a result of the experiments near Escalada and in other parts of the country the Argentine Government decided to establish a station for the preparation of the bacillus culture on a large scale, and cultures have also been prepared at the Pasteur Institute and distributed to various countries. It is claimed that the disease is not only fatal to different kinds of locusts, but also to ants, which are a serious pest in most tropical countries; it does not affect, however, chickens, rabbits, or other animals (see *Comptes Rendus*, 1911, **152**, 1413; 1912, **154**, 623).

The results obtained in other countries have varied. Satisfactory results are stated to have been obtained in

Colombia, Venezuela, and Algeria, but in the Union of South Africa and the Philippine Islands the results were not so good.

In South Africa experiments were made in 1912 on a non-migratory grasshopper, *Zonocerus elegans*, migratory locusts at the time being practically absent from South Africa. Land which was thickly infested with the grasshopper was sprayed with a highly virulent culture; but although some of the insects contracted the disease, it apparently had little, if any, effect in decreasing their number. The experiment, however, was not regarded as conclusive, and the slight extent to which the disease spread in the field was thought to be due most probably to the insects having become fully mature and having almost ceased to feed, coupled with the fact that heavy rains fell at the time and probably washed the infection from the vegetation. The Chief of the Division of Entomology states that "it appears to me in the light of the experience gained, and from the information given by the Pasteur Institute, that the disease at best can be used only as a supplementary measure in dealing with an invasion of locusts under the conditions that prevail in South Africa" (*Agric. Journ. Union of S. Africa*, 1913, **5**, 607). It is further pointed out that a culture of sufficient virulence takes some time to prepare, should be made by a competent bacteriologist, and must be used soon after it is prepared, whereas arsenical poisons can be stored for any length of time in different parts of the country, and can thus be used for the destruction of locusts as soon as they make their appearance.

Inconclusive results were also obtained in the Philippine Islands. Cultures of the disease were brought to their maximum virulence in the laboratory, after which a thorough test was made under actual field conditions on a swarm of half-grown migratory locusts (*Pachytylus migratoroides*). Very little effect was produced; a few insects were found dead, but there was no evidence of the disease spreading (*Philippine Agric. Rev.*, 1913, **6**, 547).

More satisfactory results have been obtained in Cyprus, where experiments were carried out recently by the Government Analyst. An extract from his report on the results of the experiments has been received from the Colonial Office, of which the following is a summary. The kind of locust experimented on is not stated in the report, but a collection of the locusts found in Cyprus was received at the Imperial Institute in 1911, and the one most destructive was identified by Mr. F. V. Theobald as *Pachytylus nigrofasciatus*.

The Cyprus Government received through the kindness of M. d'Hérelle three tubes containing cultures of the bacillus. On March 31, 1913, a subculture of the *Cocco-*

bacillus in broth was made from the first tube received from the Pasteur Institute, and after 24 hours the first series of locusts was inoculated. After 12 passages through 12 series of locusts it was found that the insects died from the disease in 8 to 10 hours. For fear of accidents a second subculture was made from one of the two remaining tubes received from the Pasteur Institute, and after 9 passages it was sufficiently virulent for field work. Every step was followed by a careful microscopical examination, so as not to run any risks. The inoculation of the locusts was more successful than the Government Analyst expected, and very few died from the injury caused by injecting the virus. The instructions issued by M. d'Hérelle were accurately carried out.

The field experiments were made near the village of Vatili in the Messaoria District, in the largest locust area in Cyprus. A piece of land bearing a crop of oats was sprayed on May 9, using 2½ litres of spraying fluid. Some cut barley and the uncultivated land adjoining were also sprayed. This land is near the Synta road, and contained a very large number of locusts. After 24 hours a few locusts were found to have died from the disease, and many were in a diseased state. As time went on the number of dead locusts found did not increase as had been anticipated, although many of the locusts had lost their activity. A microscopical examination of the liquid excrement from some of the dead locusts was made, and the *Coccobacillus acridiorum* was found in large numbers. On May 13 four litres of the virus were sprayed on a crop of wheat adjoining uncultivated land. The results here were a little more satisfactory, but it was noticed that the locusts were not attracted to the sprayed food, and it was therefore decided to add six lumps of sugar to the virus just before spraying. The third spraying was carried out on a large area of uncultivated land near the village of Lissi, and the sugar was added as decided. This spraying was most successful, and after two days many dead locusts were found. The last spraying was done at Kontea, and was very satisfactory. The sprayed areas were inspected daily, to observe the spread of the disease. Although the number of locusts attacked on the Synta road spraying grounds was small, the disease was slowly but surely spreading, and dead locusts were found at a considerable distance. A final inspection was made with the following results:

Synta road	1st spraying	Fairly good.
"	2nd spraying	Good.
Lissi		Very good.
Kontea		Excellent.

It was estimated that 35 to 40 per cent. of the locusts had died from the disease, and, considering the very small

expense incurred in carrying out the spraying, the result is regarded as highly satisfactory.

From the results so far obtained in different countries it seems probable that the chief value of this method of locust destruction would be to keep the insects in check and prevent them from reaching the proportions of a plague. It should be borne in mind that in time a race of locusts immune to the disease might be evolved, and M. d'Hérelle himself points out that if only a weak culture is used the insects acquire immunity.

Petroleum in Assam.—In *Mem. Geol. Surv. India* (1912, **40**, Part 1) E. H. Pascoe dealt with the oil fields of Burma (see this BULLETIN, 1914, **12**, 153). Part 2 of this volume has now appeared, and in this Dr. Pascoe gives an account of the petroleum occurrences of Assam. Although these are of much less importance commercially than the oil occurrences of Burma, it is worthy of note that exploitation by European methods was started in the Assam valley nearly twenty years before the Burma Oil Company began operations at Yenangyaung. The occurrences in the two countries are closely analogous, but whereas that in Burma has been extensively explored, comparatively little exploration has been done in Assam. In both countries the oil occurs in rocks of Tertiary age.

The petroleum localities in Assam are confined to a curved belt of country along the basins of the Brahmaputra and Surma. This belt is traceable over a distance of some 800 miles from N.E. Assam through Kachar and Chittagong to the Arakan coast, where it has a S.S.E. trend. It is roughly concentric with the trend of the Burmese oil belt, the distance between the two varying from 70 to 150 miles. Various parts of the Assam-Kachar-Chittagong-Arakan belt have been exploited in a primitive way, but there are only two properly worked fields of commercial importance, viz. those of Digboi and Bappa Pung, two localities only about a mile apart in N.E. Assam.

As bearing on the origin of the Assam oil, it is pointed out that there exists in Assam no Tertiary volcanic line corresponding to the Popa line in Burma. On the other hand there appears to be in Assam an intimate relation between the occurrences of petroleum and coal. The "compensative relationship" between the oil and the coal is emphasised as evidence of their common origin, a view which the author has previously elaborated at considerable length in Part 1, with reference to the oil fields of Burma.

Prospectors who intend to visit Assam, and do not know the country, would do well to note the obstacles that await them. "No one unacquainted with the Province can form any just conception of the obstacles to be contended with in making the most transitory survey. Transport, as soon

as one gets well into the hills, is a matter of no great difficulty; but the Nagas and Assamese along the margins of the hills and in the plain live in a state of lethargy brought about by continued fever, or by opium taken as a remedy against it, and are of little use for transport or commissariat arrangements. Roads are limited to the more inhabited parts of the plains, and footpaths are infrequent and often obliterated by the insuperable jungle, which in denseness can be matched by a very few places in the world. The best sources of exposures are the streams, up which it is usually possible to wade or paddle in 'dug-outs'; a gang of coolies to cut overhanging jungle is necessary to negotiate the smaller streams" (p. 272). These obstacles doubtless to some extent explain the fact that exploration has been less vigorously prosecuted in Assam than in Burma; and there must be many localities on the belt described by Dr. Pascoe in this memoir that have not received the attention they deserve.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the Bulletin *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India, and the Tropics generally.*

Soils and Manures

Previous investigations of the effects produced by the partial sterilisation of glasshouse soils, either by heat or antiseptics, have already been noticed in this Bulletin (1913, **11**, 151, 677). Dr. E. J. Russell's third report on this subject is given in *Journ. Bd. Agric.* (1914, **21**, 97). It records the results obtained in applying the methods, found to be satisfactory on the experimental scale, to the soils of certain cucumber, tomato, and chrysanthemum nurseries. One of the difficulties previously encountered was that of cost, which was estimated to be about 1*s.* 6*d.* per ton of soil treated, and experiments have now been carried out, in conjunction with growers, with a view to lowering this cost. Although the work on the use of chemical antiseptics was continued, none of those hitherto tested can compare with heating for nursery work, and most of the experiments recorded are concerned with this method of sterilisation.

The experiments were carried out chiefly in commercial nurseries, a house being selected which had given a bad crop during the previous year, and the whole soil being

treated. The actual method of heating varied, but four general methods were used: (1) hot water, (2) baking, (3) high-pressure steam, (4) low-pressure steam.

(1) Hot water was run on to the soil until the top 8 in. were saturated. The results obtained by this method were inconclusive. (2) Baking appears to be the most satisfactory method for small-scale work, and, according to one grower, when the operation is carried out in conjunction with other nursery work the cost is about 5½*d.* per ton of soil treated. (3) Steaming is the method preferred by most growers, and two ways of using high-pressure steam were tried. In the first the soil was treated in a box 9 ft. by 3 ft. by 18 in., which was without top or bottom and placed on a grid of iron pipes of 1½ to 2 in. in diameter perforated with ⅛ in. holes. Steam at 40 to 80 lb. pressure was passed through these pipes into the soil for about 20 minutes. This method is suitable for the soil of cucumber borders and pot tomato plants. The second method of applying steam at this pressure was used for tomato houses, and consisted in steaming the soil *in situ* usually to a depth of 9 in., but sufficient information is not yet available to determine how deep the treatment should be carried. As it is essential that every part of the soil should attain a temperature of over 200° F., less than 15 minutes' treatment is insufficient. (4) Low-pressure steam was applied in the same manner, the soils being treated for about 30 minutes with steam at 20 to 30 lb. pressure. Another method used was to fork over the soil and then invert on it a galvanised iron tray backed by boards; steam was then blown underneath and found its way into the soil, raising the temperature to a depth of 10 in. or more. If the trays were left after the steaming had been stopped the temperature fell but slowly; in one experiment it was found to be 120° F. at a distance of 8 in. below the surface of the soil, 18 hours after the steaming had been discontinued.

The cost of the different processes of treatment, as worked out at certain nurseries, is recorded.

As a general rule, germination was found to be retarded in freshly steamed soils and the rate of growth of the young plants was also diminished; the effect was not so noticeable on light as on heavy soils or those rich in organic matter. This effect soon passes away and is more than counterbalanced by the seedlings being freer from disease than those raised on untreated soil. The results obtained in the nurseries fully confirmed those previously obtained on the experimental scale and showed that useful increases in the crop can be obtained in a commercial nursery by the partial sterilisation of the soil. The method is now being tried on a large scale.

The use of certain *Acacias* in sand-dune reclamation is discussed in "An Economic Study of Acacias" (*Bulletin*

No. 9, *United States Dept. Agric.*). For sand-dune reclamation it is essential that the plant first employed should act as a binder to the soil and at the same time give rise to an increase in the quantity of humus and so prepare the soil for a profitable crop. Certain acacias are well suited for this purpose, as they can thrive either on inland barren soils or on sand-dunes near the sea. Some of them are satisfied with only a few inches of rainfall, but as they are only half-hardy as regards frost, it is essential that the temperature should not remain below 20° F. for any length of time. In warm climates these acacias may well replace grasses as a preliminary reclamation crop. A summary is given of the reclamation work carried out in South Africa and California, with the aid of acacias; from this it appears that it is unnecessary to raise the plants in nurseries, and it is recommended to use a mixture of seeds of both shrubby and arborescent types of acacia so that the growth of the larger tanning bark and timber yielding species can be started at the commencement of the reclamation. It is suggested that *A. pycnantha*, *decurrens*, *leiophylla*, and *longifolia* should be sown in combination with certain shrubby species, such as *A. longifolia* var. *sophorae*, which will give way when the sands are fixed and forest conditions established.

An account of pot culture experiments, carried out at the Woburn Experimental Station of the Royal Agricultural Society of England, on the effect of adding lime to a soil already well supplied with that constituent but containing also an excess of magnesia, is given in *Journ. Royal Agric. Soc., Eng.* (1913, **74**, 417). The experiments have been in progress since 1909, additional quantities of lime being applied each year, and the quantity of lime has been raised from 0·83 per cent. to 4·5 per cent. whilst the magnesia present in the original soil amounted to 2·29 per cent. The addition of lime in all cases produced a marked increase in the yield of corn and straw, and the results quoted indicate that beneficial results may follow the application of lime to a soil already well supplied with this constituent but which contains an excess of magnesia.

Foodstuffs

Cocoa.—An account of cocoa cultivation in Samoa is given in "Samoanische Kakaokultur," a special supplement of the *Tropenpflanzer* for April 1914. In addition to a detailed account of methods, the administration and costs of a plantation are discussed at length. The industry is principally in the hands of natives, who first planted Criollo, but of late years European planters have introduced Forastero. The latter variety, in view of its greater freedom from disease and its prolific bearing properties,

has become popular. It readily yields hybrids with Criollo, and the Samoa cocoa of to-day is mainly a hybrid of the two varieties, in the successive generations of which the characteristics of Forastero are gradually becoming more and more pronounced. The supply of labour is a difficult problem in Samoa. Owing to the reluctance of the native for regular work, it was necessary to procure Chinese coolies, many of whom proved to be poor workmen, and difficult to manage. It is stated that the cost of a cocoa tree up to the time of bearing is 5 marks with Chinese labour, and 6½ marks with native labour. In either case, it is pointed out, the cultivation proves very remunerative; each tree brings in a profit of 1 to 2½ marks per annum during the first years of fruiting.

Coffee.—The cultivation of coffee in the Bukoba district of German East Africa is described in *Der Pflanzer* (1914, **10**, 133). The industry is chiefly in the hands of the natives, who grow, almost entirely, *Coffea bukobensis*. European planters have introduced *C. arabica*, which is now also being planted by the natives. A feature of the Bukoba cultivation is the utilisation of the banana as a shade and protection against wind for the young coffee plants. The Bukoba coffee tree grows to a height of 6 metres, and yields on the average a crop of 4 to 10 lb., but in some cases as much as 30 to 40 lb. It is stated that Bukoba is particularly free from coffee pests, the only one of note being *Stephanoderes coffeae*, Haged. Hemileia, the recent appearance of which in the Nairobi district and in Uganda has aroused interest, also occurs in Bukoba, but to a very slight extent. In the opinion of the writer the leaf disease which has in the last year caused alarm in Uganda is probably not Hemileia, but *Colletotrichum coffeae*, Massee, a disease which has not yet appeared in Bukoba.

Tea.—In an article which appeared in the *Indian Planters' Gazette* (1914, **50**, 709) attention is called to *Indigofera arrecta* as a suitable green manure for tea. Three methods of employing this plant as a green manure are possible. (1) It may be sown broadcast between the rows of tea bushes and hoed in when from 2 to 3 ft. high. (2) It may be grown as a separate crop in a field apart, and the successive crops of stems cut down and applied in shallow trenches opened out between the tea bushes. (3) It may be grown on one block of the tea plantation between the bushes, and the first crop of stems cut and applied as manure to another block, the second crop being hoed in on the block on which it grew; where this method is adopted the sites for growing the crop are reversed each year. The last-named method is said to give the best results. Where systematic green-manuring on these lines has been practised for a number of years, together with

deep hoeing and forking during the winter, even old and declining tea is said to have responded to the treatment and given flushes equal to young tea at its best. Spasmodic attempts at green-manuring are said to be of little value, and in order to obtain good results the process is best carried out on a pre-arranged working plan covering three or four years.

Wheat.—The *Rep. Agric. Research Inst. Pusa*, 1912–13, p. 26, reviews the present position of the Indian wheat investigations, and shows that wheats of the highest class have been produced to meet the requirements of the various wheat-growing districts. An important feature of the recent tests was the superiority in the milling and baking trials of the samples of "Pusa 12" from stations in the Indus Valley, *i.e.* Lyallpur, Mirpurkhas, and Gurdaspur, over those grown in the Ganges Valley. Wheat-breeding experiments are in progress to improve the best of the Pusa wheats in standing power, rust resistance, and in general hardiness. For this purpose crosses between Indian wheats of good grain quality and various English and American varieties were made in England in 1910, and two series of these hybrids are now in the fourth generation, the results so far being most promising. Experience shows the necessity of improving the standing power of Indian wheats, and this will be the object of future experiments.

Sugar.—The results of sugar-cane experiments at Tzaneen Experiment Station, in the Zoutpansberg District of the Transvaal Province, are recorded in *Agric. Journ. Union of S. Africa* (1914, **7**, 314), and are stated to be very satisfactory. "Uba," the most successful cane in Natal, and "Demerara" were the two varieties grown, and yielded 28½ tons and 19¼ tons of cane per acre respectively. The "Uba" cane yielded a juice containing 21 per cent. cane sugar, which is slightly more than the maximum figure for Natal-grown cane. The juice from the "Demerara" cane contained 20·4 per cent. of cane sugar. The results show the possibility of sugar-cane growing on the Transvaal low veld, but the question of labour and competition with the established industry in Mozambique and Natal are important factors to be considered before attempting the cultivation on a commercial basis.

Bananas.—In Fiji the ravages of the "banana borer" (*Cosmopolites sordida*, Chevr.) had grown to such alarming proportions in spite of all artificial methods of control that a mission to Java was undertaken in November 1912 with a view of discovering natural enemies of the borer which were reported to exist there and in Papua. The results of the expedition are contained in *Bulletin* No. 7, 1914, *Dep. Agric. Fiji.* The most satisfactory parasite proved to

be a *Histerid* beetle, *Plaesius javanus*, Er. The adult beetle consumed in captivity an average of 8, and the larva 33·8 fully grown grubs of the banana borer per head per day. Five thousand beetles were conveyed to Fiji in moist earth, of which number 3,792 arrived alive. Batches of 500 were distributed to seven plantations in badly infested districts, and from the fact that after a period of four months the beetles were reproducing it is considered that the climatic conditions of Fiji are suitable, and that the beetles are now probably established in the country. The transmission of beetles packed in damp moss by post from Java to Fiji was successful, and would prove a simple means of obtaining a further supply if necessary.

Oils and Oil Seeds

Castor Seed.—An account is given in the *Rhodesia Agric. Journ.* (1914, **11**, 529) of experiments made with this crop in South Africa. At the Experiment Station near Pretoria it was found that the large-seeded varieties (*Ricinus zanzibarensis*) bore larger crops than the small-seeded (*R. sanguineus* and *R. communis*). When the plant was grown as a perennial an average annual yield of about 1 lb. of seeds per tree was obtained. This yield was confirmed by subsequent trials at Salisbury, but it was found that many of the plants died during the second year. When the large-seeded varieties were treated as an annual crop (5,000 plants to the acre), a yield of only 600 lb. per acre was obtained, due to the planting being too close. Experimenters in the Hartley district, which lies at a considerably lower altitude than Salisbury, report much heavier yields, up to 3 lb. of clean seeds per tree being obtained. One farmer on the sand veld has estimated his average return at 1,000 lb. of clean seeds per acre. The oil content of the seeds grown in Rhodesia varies from 49 to 52 per cent., and is thus quite normal.

Coconuts.—In their recent work, *All about Coconuts*, Belfort and Hoyer state that "at present there is a great scarcity of land suitable for successful coconut growing" in Ceylon. According to the *Tropical Agriculturist* (1914, **42**, 330), this statement is not quite correct, as there are still fairly extensive areas awaiting plantation. A large tract was bought up recently in the Puttalam district, which goes to show that even in the drier districts the prospect is promising. It is considered that the possibilities are good in some of the more remote parts of the island, *e.g.* the Sabaragamuwa Province, while there is a good deal of land far from the recognised coconut districts awaiting enterprising planters.

The cultivation of coconuts and drying of copra are being taken up by a large Austrian company in Sumatra

(*Agron. trop.*, 1914, **6**, Pt. ii. p. 49). In the north of the Achin Province, drying plant has been erected at Aleh-Aleh, and plant is also to be erected in other places. The company has land in the isles of Nias and Simaloer, and 5,000 hectares are already planted in Langsar.

Existing coconut plantations in Antigua are in a promising condition, but some lands will need to be drained in the near future (*Rep. Bot. Station, Antigua*, 1912–13, p. 28). Experimental plots have been started to ascertain whether coconuts can be grown successfully on the abundant heavy lands of Antigua. Growers are advised to use nuts from old trees for planting, as in the experiments those from young trees failed to germinate well. Unhusked nuts from Antigua are smaller than those from Dominica and Nevis, but the difference is merely due to the thinner layer of coir on the Antigua nuts.

A mill for producing coconut oil, and capable of dealing with 65 tons of copra in 24 hours, has been working for some time in Manila (*Indian Trade Journ.*, 1914, **33**, 7). A larger mill to deal with 130 tons per 24 hours is to be established farther south, near the coconut plantations.

An illustrated article on the bud-rot disease of coconut palms in Malabar by Shaw and Sundararman is contained in the *Agric. Journ. India* (1914, **9**, 111). The coconut palm is by far the most important crop in many parts of Malabar, South Canara, Cochin, and Travancore, and the suppression of this disease is therefore of great importance. In certain districts Palmyra palms have suffered severely from attacks of bud-rot (*Pythium palmivorum*, Butl.), and during the last five years over 400,000 trees have been cut down and burned in the Godavari district alone in order to keep the disease in check. Coconut palms had not been found to be attacked to any serious extent until October 1912, when numbers of trees in all stages of the disease were observed in the neighbourhood of Calicut, and the disease has also been identified in other parts of Malabar. An unfortunate feature of the disease is the difficulty of recognising it in its early stages, and even when recognised, remedial measures are difficult. The safest plan is to destroy the tree, and active measures are now being taken to check the disease by this means. An important factor in the development of the disease is the degree of moisture. In the case of Palmyra palms, a high death-rate of trees is associated with a great humidity of atmosphere. The damp fogs prevalent during the cold months in the Godavari district are particularly favourable to the growth of the fungus.

Cotton Seed.—During the official year 1912–13, 11,073 tons of cotton seed were exported from Davangere, the ginning centre of the Mysore cotton industry. None of this was

used for sowing purposes, and it is estimated that about 10,000 tons of cotton seed are annually available for industrial purposes. In order to utilise the cotton seed available, an oil mill is to be erected in the State of Mysore, either at Davangere or at Haribar (*Indian Trade Journ.*, 1914, **33**, 211). The Mysore Government has promised to take shares to the extent of half a lakh of rupees, provided the balance is subscribed by the public.

Ground Nuts.—In continuation of the work done in Montserrat in previous years with ground nuts, a comparative test of five varieties has again been made (*Rep. Bot. Station, Montserrat*, 1912–13, p. 13). The best yield was obtained from the Gambia variety, which gave 1,236 lb. of dry nuts per acre. The average yield of this variety over four years has been 1,570 lb. of dry nuts per acre, and it is thought that the cultivation of the ground nut on an estate scale would probably not be very remunerative. Its cultivation on the lighter lands in rotation with cotton might, however, be worth considering, and a good deal might be done by small growers for the purpose of local consumption and for inter-island trade. Samples of Gambia and other varieties of ground nuts grown experimentally in Montserrat have been examined at the Imperial Institute, and the results of their examination and commercial valuation were published in this Bulletin (1913, **11**, 578).

According to the *Rhodesia Agric. Journ.* (1914, **11**, 513), the British South Africa Company is about to erect an oil mill at Salisbury, Southern Rhodesia, principally for the crushing of ground nuts. Sunflower seed and possibly linseed and castor seed will also be treated. It is stated that farmers situated on the sand veld will possibly make ground nuts a staple crop in place of maize. The production of oil-cake in that district will be a great boon to dairy farmers and stockmen generally.

Oil Palm.—The oil palm was introduced into Ceylon at Peradeniya in 1850 (*Trop. Agriculturist*, 1914, **42**, 178), but the small number of trees now growing there have only produced a few seeds at this elevation (1,650 ft.). Seeds from these trees have been sown, and 5,000 seeds are being obtained from Africa for trials at the new Anuradhapura Experiment Station, as it is considered that the oil palm may prove suitable for cultivation in the low country of Ceylon.

According to Chevalier (*Journ. d'Agric. trop.*, 1914, **14**, 112), the oil palm has only been grown as an ornamental tree in Indo-China up to the present time. A number of trees were examined by him in various parts of the country during his recent mission to Indo-China, and he considers that the tree is likely to become important to planters, as it seems to thrive as well there as in West

Africa. Although the palms bear fruit of good quality, the number of bunches is smaller than in Africa, and the fruit heads are of smaller dimensions; this is probably due to the trees not having received sufficient care. The small number of developed fruits in the bunches and the larger number of aborted fruits appear to be caused by lack of fertilisation, which may be due to the absence of strong winds or of certain insects which assist fertilisation, but is more probably due to the fact that the oil palms are widely distant from one another, and are consequently unfavourably situated for cross-pollination. According to Chevalier, the male and female flowers on the same tree mature at different times, and cross-fertilisation is therefore essential to the formation of fruits.

In Sumatra the oil palm has only been worked on an insignificant scale by natives up to the present time (*Agron. trop.*, 1914, **6**, Pt. ii, p. 49); but it is now attracting the attention of capitalists, and it seems likely that its cultivation and exploitation may become a matter of importance.

The oil palm is very abundant in the Stanleyville district, Belgian Congo, between Ponthierville and Kindu (*Dipl. and Cons. Rep. Ann. Series*, No. 5260 [Cd. 7048–77], 1914, p. 21). Its exploitation should attract the attention of merchants, as large quantities of oil appear to be obtainable from the natives.

Candelilla Wax.—The *Bd. of Trade Journ.* (1914, **85**, 285) states that a ten-years' contract has just been granted by the Mexican Government for the exploitation of the candelilla plant over an area of 100,000 hectares (about 247,000 acres) situated in the States of Durango, Zacatecas, and Coahuila.

Miscellaneous.—It is stated in the *Monthly Rep., Cent. Econ. Bd., Sudan*, March 1914, p. 40, that in consequence of the very high price of sesamum seed, experiments are being made at the soap factory at Singa, Sudan, in the extraction of oil from the "lalob" seed, *Balanites aegyptiaca*. For the results of examination of these seeds and of the oil yielded by them, see this Bulletin (1908, **6**, 364).

An article is quoted in the *W.I. Agric. News* (1914, **13**, 148) which calls attention to the popularity in the American markets of three new edible nuts, the best known being the "pili" nut of the Philippines. Pili nuts of commerce are apparently derived from fruits of *Canarium ovatum* and *C. luzonicum* of the Philippines, and to a slight extent from *C. commune* of the Dutch East Indies. The second kind is the "paradise" nut grown in Brazil, Venezuela, and Guiana, and closely allied to the Brazil nut. It is stated to contain as a rule about 39 per cent. of oil. The third nut referred to is the "Queensland" nut, *Macadamia ternifolia*. Small shipments made from Queensland to London

are said to have brought *12s.* per lb. at Covent Garden Market.

Essential Oils

Camphor.—On behalf of the Monopoly Bureau of the Government of Formosa in connection with the camphor industry, two oils derived from trees resembling *Cinnamomum camphora* have been examined (*Perfumery and Essential Oil Record*, 1914, **5**, 244). The trees are known locally as Shô-Gyū and Yu-Ju, and have not yet received botanical designations. The Shô-Gyū tree yields from 1·3 to 3 per cent. of oil, with specific gravity varying from 0·900 to 1·031 at 15° C. and optical rotation from + 7° 75′ to + 34° 45′. The following constituents have been identified in the oil: formaldehyde, sabinene, dipentene, α-terpinene, γ-terpinene, terpineol-4, geraniol, citronellol, safrole, and eugenol. The Yu-Ju tree yields from 3 to 4 per cent. of oil, having a specific gravity varying from 0·942 to 0·967 at 15° C.; optical rotation + 18° 8′ to + 30° 8′. In addition to camphor and considerable quantities of cineole the following constituents have been identified in the oil: furfurol, α-pinene, β-pinene, camphene, dipentene, α-terpineol, safrole, and eugenol. It is estimated that Formosa could produce approximately from 1,092,000 to 1,170,000 lb. of Shô-Gyū oil, and from 65,000 to 78,000 lb. of Yu-Ju oil annually.

Hop Oil.—By examining the physical and chemical properties of the oil, F. Rabak has sought to differentiate between hops derived from various geographical sources (*Journ. of Agric. Research*, 1914, **2**, 115). The result of his experiments show that the source of hops may be indicated by the ester value of the oil; it is not yet possible to state definitely, however, whether the proportion of esters in the oil has any definite relation to the quality of the hops.

Oil of Phoberos cochinchinensis.—Messrs. Roure-Bertrand Fils (*Bulletin*, April 1914, p. 7) have examined a sample of oil of *Phoberos cochinchinensis*, Lour., distilled in Annam. The oil possessed an odour resembling that of sweet orange of Portugal, and was considered of value for perfumery purposes. The leaves and green stems yielded about 0·09 per cent. of oil which possessed the following constants: specific gravity at 15° C. 0·9042, optical rotation + 3° 2′, acid value 2·5, ester value 51·1, acetylation value 127·9.

Rubber

Hevea brasiliensis.—Experiments by Ruys (*Le Caoutchouc et la Gutta-Percha*, 1914, **11**, 8317) show that it is advantageous to plant heavy seed. Groups of seed of different weights were planted with the following results:

	Number of seeds.	Total weight.	Number germinated.	Average height of stems after 20 weeks' growth.
		Grams.		*Centimetres.*
1	24	141·5	20	65·5
2	24	116·5	18	55·5
3	24	86·5	13	42
4	24	42·5	4	24

No seed under 4 grams in weight should be planted.

The methods of working rubber plantations in Cochin China, where large areas of land suitable for Hevea cultivation exist, are described by Girard in *Bulletin Econ. de l'Indo-Chine* (1914, **17**, 47). The yields of rubber in the dry season instead of being less than those obtained in the rainy season, as is the case in many other countries, may be as much as 50 per cent. greater. The Annamite labourers are particularly dexterous, and on the average each man taps 600 trees per day, while women can tap 450 trees per day. After making a number of experiments, and studying the methods of tapping used in Malaya and other countries, the following method has been found most suitable for Cochin China: one-fifth of the circumference is tapped with three fine cuts (1 millimetre wide) at an angle of 15°, separated from one another by a distance of about 22 in. The cuts are reopened daily, and it takes about a year to tap one-fifth of the circumference. This method yields a constant flow of latex with a minimum amount of bark removal. Further experiments are being made.

A useful article on the tapping of Hevea has been contributed by Cayla to the *Journ. d'Agric. Trop.* (1914, **14**, 73, 161) in which the results of all the more important experiments carried out during recent years are summarised.

A fungus attacking the leaves of Hevea trees in Surinam is described by Kuyper and named by him *Fusicladium macrosporum* (*Trop. Agriculturist*, 1914, **42**, 268). It is probably the same fungus which attacks Hevea in Brazil and which has been named *Dothidella Ulei*. Young trees in the nurseries are most liable to attack, but Kuyper says that 6-year-old trees may succumb to repeated attacks. Old trees which have been attacked frequently should be destroyed, while Bordeaux mixture may be used in less severe cases. The disease exists in three forms: the first two forms attack the leaves and produce holes in them or cause defoliation; the third form attacks the stems and leaf-stalks and produces swellings which may form canker-like patches.

Chèneveau and Heim give the results of comparative tests on vulcanised rubber prepared from smoked and unsmoked Hevea crêpe made in Indo-China and from fine hard Para (*Bulletin de l'Off. Col.*, 1914, **7**, 154). The results

given by the smoked crêpe were superior to those yielded by unsmoked crêpe and similar to those given by the fine hard Para. In this investigation all the samples were vulcanised for the same period of time, whereas it is necessary in such work that the optimum time of vulcanisation for every specimen should first be determined.

Landolphia spp.—Jumelle and Perrier de la Bathie have published (*Le Caoutchouc et la Gutta-Percha*, 1914, **11**, 8173) a paper on the rubber of *Landolphia Mandrianambo*, Pierre, a large rubber vine occurring in the eastern part of Madagascar. The character of the rubber is liable to great variation, which was found to depend partly on the age of the tree and the locality where it was grown, and largely to the differences existing in the latex furnished by different tissues of the stem; the phloem was found generally to yield a rubber of good physical properties free from tackiness, while the other tissues, such as the cortex, pericycle, and pith, yielded viscous non-elastic products.

Manihot spp.—In connection with the crisis in the German East African Manihot rubber industry caused by the present low prices of rubber, Marckwald and Frank call attention (*Der Tropenpflanzer*, 1914, **18**, 216) to the desirability of exporting Manihot rubber in ball form in a moist condition and not as dry washed crêpe or sheet. The low price which Manihot rubber commands appears to be largely due to the uncertain results which it gives when vulcanised; samples of the rubber in form of sheet or crêpe of good appearance frequently give very poor results on vulcanisation. According to the authors the washing of Manihot rubber in Africa previous to export renders it very liable to oxidation with consequent loss of "nerve." In support of their recommendation to export in moist form, they quote the fact that moist rubber from South Kamerun packed in barrels sells by name without sample, and realises about 1*s.* 10*d.* per lb. (March 1914).

Miscellaneous.—It is reported (*Board of Trade Journ.*, 1914, **85**, 50) that a company has been formed to exploit *Euphorbia Drageana*, E. Mey., in Namaqualand. The latex is said to yield a product containing 70 per cent. of resin and 17·6 per cent. of rubber. The company has a concession of about 220 sq. miles, on which there are about 6,000,000 plants.

Fibres

Silk.—In the *Rep. Agric. Dept., Bengal, for the year ending June* 30, 1913, an account is given of a new scheme which has been devised with the object of reclaiming the silk industry. The aim of the scheme is gradually to establish throughout the silk districts a sufficient number of central nurseries with rearing houses

and thus enable the whole of the seed cocoons required in the province to be supplied under Government supervision. It is believed that this is the only really effective method of dealing with the problem. A number of the existing smaller nurseries were closed during the year and others are being converted into enlarged and improved central nurseries with rearing houses complete. The ultimate success of the scheme depends largely on the willingness of the rearers to pay an adequate price for pure seed.

A short account of the silk industry of Madagascar is given in *Journ. d'Agric. Trop.* (1914, **14**, 89). The natives of the centre of the island obtain silk both from the native silkworm or "landibe" (*Borocera madagascariensis*) and also from the mulberry silkworm (*Bombyx Mori*), which was introduced about seventy years ago. The "landibe" lives in natural forests of *Uapaca clusiacea* or in artificial plantations of *Dodonea madagascariensis* and *Cajanus indicus*. It gives two harvests a year; the cocoons are brown or grey, and the silk cannot be reeled, but is carded and spun. The cocoons are an important article of internal trade. The silk is comparable with the tussah variety, and by the adoption of appropriate measures the production could be considerably increased. The mulberry silkworm is cultivated in the vicinity of Antananarivo, Antsirabe, and Ambositra, and the number of rearers shows a continuous increase. The silk is not yet being exported, but is used locally. As it is considered that sericiculture is an interesting domestic industry which might be of value in improving the material condition of the natives of the centre of the island, great efforts are being made to develop it. The races cultivated were introduced from Europe, but they have adapted themselves to the local conditions and become polyvoltine, five generations being produced annually. The Nanisana Station is devoted to the study of the silkworm and the production of disease-free seed; it distributes annually about 300,000 layings of carefully selected silkworm eggs and 250,000 mulberry plants.

Paper-making Materials.—Attention has been drawn in this Bulletin (1913, **11**, 163) to the value of the stems of *Hedychium coronarium* from Brazil for paper-making. An account is given in the *Kew Bulletin* (1914, No. 4, 165) of an examination by Messrs. Clayton Beadle and Stevens of dried specimens from Calcutta. This material furnished a good, strong, elastic paper which would be serviceable as a wrapping paper. It is considered probable that *Hedychium coronarium* will be found to possess good paper-making qualities from whatever part of the world it is obtained. The Indian product gave slightly different results from that from Brazil, but this is attributed to differences in the preparation of the raw material prior to

shipment rather than to any actual difference in the plant itself. On p. 175 of the same publication reference is made to the results of experiments in planting *Hedychium coronarium* in British Guiana. The first trials failed on irrigated land, but on the tidal parts of the rivers above the brackish-water sections the plant grew well on swampy land and yielded stems 6 ft. 6 in. long as compared with a length of 2 ft. 6 in.–3 ft. on dry soil.

In *Der Pflanzer* (1914, **10**, 202) reference is made to a report of the German Consul at Merida, Yucatan, Mexico, which states that a company has been established in Mexico for the manufacture of paper from the refuse of the henequen (Sisal hemp) industry. A large quantity of henequen stumps and leaves has been tested in a paper-mill in New Orleans and the material has been found to yield a very strong paper. It is estimated that from 15 to 20 million henequen stumps are allowed to decay every year, and, in addition to these, there is the enormous mass of leaf-refuse obtained in extracting the fibre. A mill is to be erected in Yucatan capable of working up 15 to 20 tons of the raw material per day. The work will be restricted at first to the manufacture of half-stuff for export. If this project proves successful, it will be of considerable importance to the Sisal hemp industry.

Cotton

Egypt.—Reference to the cotton industry of Egypt is made in the *Reports by H.M. Agent and Consul-General on the Finances, Administration, and Condition of Egypt and the Sudan in* 1913. The crop yielded an excellent first picking, but the second picking was somewhat poor owing to the exceedingly low flood. It was anticipated that the estimated crop of 7,554,000 kantars (1 kantar = 99·05 lb.) would be approximately realised. The total area planted was 1,723,094 feddans (1 feddan = 1·038 acres) as compared with 1,721,815 feddans in 1912. The areas planted with the different varieties were as follows: Mitafifi, 623,737 feddans; Ashmouni, 356,485 feddans; Yannovitch, 173,439 feddans; Sakellaridis, 247,292 feddans; Nubari, 201,137 feddans; Assili, 65,958 feddans; Abassi, 37,383 feddans; Voltos and other varieties, 17,663 feddans. The quantity of cotton seed distributed by the Government amounted to 90,096 ardebs (1 ardeb = 5·44 bushels) as against 42,273 ardebs in 1912. Cotton-breeding experiments have resulted in the production of four new strains, and it is hoped that by further experiments an early maturing cotton will be obtained which can be harvested before the boll-worm has time to hatch. At thirty-eight demonstration farms endeavours have been made to show the small farmer how to cultivate more intelligently and economically with the

means and labour at his disposal. In order to check the over-watering of the soil, the unduly large discharge outlets from the canals have been replaced by pipes of varying dimensions, according to the size of the area to be served. The efforts to check the ravages of the cotton worm have been continued with considerable success. Reference is made to the alarming increase of the pink boll-worm (*Gelechia gossypiella*) and to the measures undertaken for its control (compare this BULLETIN, 1914, **12**, 312).

Sudan.—An account of the progress of cotton growing in the Sudan is given in the *Secretary's Annual Report for* 1913, *Central Economic Board, Sudan Government* (No. VII). The principal points of interest are that work has been commenced on the Gezira Irrigation Scheme; that almost the whole of the cotton is now ginned before export; that the importation of cotton seed from Egypt has been prohibited in order to guard against the introduction of the pink boll-worm, the Sudan being thus compelled to depend on home-grown seed in future; and that both Egyptian and long-stapled American cottons have been grown experimentally at Tokar with great success from acclimatised seed. The exports in 1913 amounted to 2,318 tons of ginned cotton, 39 tons of seed-cotton, and 4,785 tons of seed. The total value of the exports was somewhat greater than in 1912, although the quantity was rather less. The sources of the cotton and the proportion derived from each were as follows: Tokar, 72 per cent.; Khartoum district and Nile Valley north of Khartoum, 17 per cent.; Tayiba, 7 per cent.; other cotton, mostly rain or flood-grown, 4 per cent. The better grades of Tokar cotton realised higher prices than "fully good fair" Egyptian, but the later pickings showed considerable deterioration, which was partly due to the prevalence of the Asal fly. The native cultivators of the better class are now showing keen interest in the use of labour-saving implements and have used the plough for the first time, ploughing more than 500 acres. Experiments at Tokar with seed of Egyptian Mitafifi and King's and Sunflower American varieties, all of which had been acclimatised for two seasons, showed improved germination, earlier production, and larger yield, and the crop exhibited no deterioration in staple. The American kinds give larger crops than the Egyptian, and it is considered that when the rainfall is about 100–110 mm. the American type is the more suitable. Great interest is being taken in the crop by the natives of the Kassala Province, and the crop for 1913 amounted to about 343 tons of seed-cotton. In the Blue Nile Province there is not much Egyptian cotton grown except at the Tayiba Farm; this is due to the fact that, owing to the very small rainfall, satisfactory results cannot be expected. Similarly in the Berber Province the

natives are disinclined to grow Egyptian cotton except on land artificially irrigated. On the Zeidab Estate the best results were obtained with the Sakellaridis and Nyasaland varieties.

India.—The Report of the Imperial Cotton Specialist (*Report of the Agric. Res. Inst. and Coll., Pusa, for* 1912–13, pp. 93–119) contains interesting information on the progress made in the improvement of cotton growing in the various Provinces of India. In the North-West Frontier Province the local variety is so productive and so well suited to the country that it is considered undesirable to replace it by any other kind. This cotton consists of a mixture of varieties of the *G. neglectum* type, and it is recommended that efforts should be made to improve it by selection.

In the Punjab a number of varieties have been grown on the Lyallpur Farm for several years, and their suitability for the local conditions has been thoroughly established. It is thought that the most promising of these should now be subjected to selection and multiplication with a view to distributing them to cultivators. It is pointed out that only one variety or type should be introduced into each tract or district, as otherwise complaints will be made by buyers that the cotton is of mixed quality and the cultivators will suffer in consequence.

In the United Provinces encouraging results have been obtained with American cottons, but data have not been furnished hitherto to prove that they are really profitable to grow. Experiments are in progress in connection with the indigenous varieties.

In the Central Provinces the hardy indigenous varieties are now giving such satisfactory crops, and furnish a product so well adapted to the needs of the market, that there is no incentive to grow longer-stapled cottons, and especially so as the latter do not seem well suited to the local conditions of soil and climate.

In Madras experiments at the Nandyal and Hagari Experimental Stations have demonstrated very clearly that a rapid deterioration takes place, even in Indian cottons when their environment is changed, and show that fresh seed of such varieties must be continuously imported. This is particularly the case with the Broach seed introduced into the cotton districts by the seed farm at Hagari. At the Nandyal Station types of cotton have been produced which, in point of yield and ginning percentage, are 10–20 per cent. superior to Kumpta and 30–40 per cent. to Westerns. The introduction of Cambodia cotton into Madras was at first attended with excellent results; the cotton was grown on good soil with well irrigation, the land was thoroughly ploughed, and special attention was

paid to the cultivation. Recently, however, the cotton has been planted on any land and only roughly cultivated, and the fields have been found to contain a considerable proportion of plants of the Uppam and Karunganni types. As a result, the quality of the Cambodia cotton has suffered, and if steps are not taken to keep the type pure and free from the local varieties, the product will fall in value to the level of the ordinary native kinds.

In Bombay some interesting results have been obtained at the Dharwar, Gadag, and Nadiad Farms. At Dharwar Broach cotton has shown a continuous deterioration to the local Kumpta type, and it is considered that in order to maintain the character of this cotton, the seed must be renewed over the whole area once in every three years. Selection of the Kumpta cotton has been continued, and hybridisation experiments have led to the production of several promising hybrids. Cambodia cotton has proved unsuited to the conditions of Dharwar. The Dharwar American cotton is said to have suffered deterioration, and this is probably due to the admixture of a superior with an inferior type. In the Ahmedabad District Cambodia was grown with success and reached higher prices than the local Lalio cotton. It is regarded as probable, however, that the Lalio variety will not be readily displaced by Cambodia, as the latter is more delicate and more susceptible to frost and insect pests.

In connection with experiments on the improvement of the cotton of the United Provinces which have been in progress during the last ten years, an interesting and well-illustrated account of that part of the work which deals with the vegetative characters has been given by H. Martin Leake and Ram Prasad in the *Memoirs of the Dept. of Agric. in India, Botanical Series* (1914, **6**, No. 4). It is shown that the vegetative characters are of considerable indirect importance in relation to the cotton crop. The habit of the plant is largely dependent on the method of branching, and on this habit depend such vital points as the suitability of the plant for field cultivation and the yield of seed-cotton per acre.

It is stated in the *Rep. Dept. Agric., Burma, for the year ended June* 30, 1913, that a crop grown at Tatkon yielded 1,200 lb. of seed-cotton per acre, although it had been severely attacked by insect pests which stained the fibre and consequently reduced its value. The product was examined at the Imperial Institute and found to be of fairly good quality, and decidedly superior to the local indigenous varieties. The cultivation of this cotton is being encouraged. Cambodia cotton can be grown on the higher soils in Lower Burma with good results in respect of both yield and quality; the seed should be sown in August or September. Good cotton has also been grown on a rubber plantation in the

Henzada District, and seed has been distributed to several rubber plantations in Pegu and Hauthawaddy. The cultivation of tree cotton in Tenasserim has been continued.

West Indies.—An account of the progress of the cotton industry in Antigua and Barbuda is given in the *Rept. on the Botanic Station and Experiment Plots, Antigua*, 1912–13. In Antigua 800 acres were planted in 1912–13 as compared with 433 acres in the previous year, and yielded 197 lb. of cotton per acre, this being the largest return per acre hitherto secured in the island. The whole of the cotton was of the Sea Island variety. Some damage was caused by leaf blister mite (*Eriophyes gossypii*) and caterpillars (*Alabama argillacea*). In Barbuda 130 acres were devoted to the crop, and yielded 230 lb. of cotton per acre. No serious attacks of insect pests were experienced.

Drugs

Belladonna.—Experiments carried out by A. F. Sievers to determine the distribution of alkaloids in the various parts of the belladonna plant are recorded in the *Amer. Journ. Pharm.* (1914, **86**, 97). The determinations were carried out on four third-year plants in full bloom, and six first-year plants after flowering, when nearly all the berries were ripe. The following average percentages of alkaloids were obtained: In the third-year plants the flowers gave 0·385; flowering tops, 0·865; leaves, 0·475; stems, 0·292; roots, 0·448; entire plant, 0·444. In the first-year plants the leaves gave 0·686; young sprouts, 0·9315; fruit, 0·3192; stems, 0·1145; roots, 0·4605; entire plant, 0·343 per cent. These results agree with the observations of Gerard (*Year-book of Pharm.*, 1880–81, p. 482) as to the proportion in which the alkaloids are distributed among the various parts of the plant. The percentage of alkaloids in small young leaves, stems, and roots was found to be greater than that in the same parts of the plant when larger and older. In further experiments seven four-year-old plants were dug up, their roots divided into bark and wood, and the amount of alkaloid in each part determined. It was found that in each case the wood was richer in alkaloid than the bark. Analyses were also performed on the leaves of various species of *Datura*, and it was found again that small young leaves were richer in alkaloids than older and larger leaves. The author points out that his experiments indicate that all parts of the belladonna plant, except the large woody stems, contain enough alkaloid to render their utilisation practicable.

Indian Hemp (*Cannabis indica*).—The *Official Gazette of the East Africa Protectorate* (1914, **16**, 571) contains a Government notice (No. 100 of 1914), which lays down certain

rules to be observed in the East Africa Protectorate under the Abuse of Opiates Ordinance, 1913, section 18. These rules declare it illegal to sow, cultivate, or otherwise grow Indian hemp (*C. indica*) in the Protectorate, under penalty of imprisonment or fine, and authorise any police officer or village headman to destroy any growing plants.

FORESTRY: FOREST PRODUCTS

Shade Trees for Tea and Coffee.—In an article contributed to the *Planters' Gazette* (1914, **50**, 707) the writer gives the following as qualities that an ideal shade tree should possess: It should be a quick grower; its leaves should be small so as to cast a light but even shade, and to enable them, when they fall, to pass between the branches of the tea or coffee bushes on to the soil; it should not produce a heavy drip, which would injure the crop, and it should not exhaust the soil, but, rather, should enrich it by adding leaf-soil or by fixing atmospheric nitrogen. The last-named property is possessed by trees belonging to the natural order Leguminosæ. The two leguminous trees that are said to be the most suitable for use in India as shade trees for tea or coffee are the sau of Assam (*Albizzia stipulata*) and the sishum (*Dalbergia Sissoo*), the latter being the better. Both species are rapid growers, and supply a light shade and good leaf-mould. The sau is, however, liable to be damaged by winds. The sishum is described as a strong grower, with wide-spreading branches clothed with small leaves that are shed profusely; the timber is of good quality, and is employed both for building and for furniture. When once established sishum requires little care and hardly any pruning during the first ten or fifteen years. Sishum trees grow in many parts of India, and seeds are readily procurable. The methods of cultivation are stated to be as follows: Seeds are sown at the commencement of the rains in lightly dug nurseries, and the seedlings, when about a year old, are planted out about 20 ft. apart between the rows of tea. After about ten or fifteen years, if the trees are found to be crowded, every alternate one is cut out.

Timbers

Indian Timbers for Matches.—In an article on the Indian match industry which appeared in the *Indian Agriculturist* (1914, **39**, 55), the woods of the following species are said to be employed in Burma for match splints: *Bombax insigne*, *B. malabaricum* (simul), *Anthocephalus Cadamba* (kadam), *Sarcocephalus cordatus*, *Spondias mangifera* (amra), and *Engelhardtia spicata* (palash). These woods are not the best for the purpose, but are those most easily procurable.

There are other kinds of white wood, such as poplar, pine, willow, and alder, in abundant quantities, but they are difficult to extract and transport, and are therefore costly. Until recently the bulk of the supply of matches used in India has come from Norway and Sweden, but Japanese matches now enter the Indian market. The matches made in Japan are inferior to those of European origin, but they are able to compete successfully with the latter owing to their cheapness.

The attempts to manufacture matches in India have not hitherto been attended with great success, but recently two well-equipped factories have been started in Burma which give promise of good results. One of these is in Rangoon and is owned by Chinese; the other is at Mandalay, and is under European management.

Further investigations are said to be necessary in order to settle the question as to the most suitable woods to employ, and when these have been brought to a satisfactory conclusion it is thought that Burma will be able to produce matches of first-class quality.

Tanning Materials

"Pine" Bark (*Callitris* spp.).—It has been suggested that an investigation be undertaken to deal with the question of the commercial utilisation of the bark of the so-called pine trees of Australia (*Journ. Soc. Chem. Indust.*, 1914, **33**, 232). The two species most frequently met with are *Callitris calcarata* and *C. glauca*. Their barks contain, on an average, 20·9 per cent. and 12·3 per cent. of tannin respectively, and although when used alone they impart a deep red colour to the leather tanned with them, they can be used satisfactorily in admixture with certain other tanning materials. There are large areas under these trees in Australia, and it is considered that the profitable exploitation of the barks will depend on their successful manufacture into extract, for which a likely market will be found in Australia, as that country, at the present time, imports large quantities of wattle bark from South Africa.

Wattle Bark.—Preliminary experiments carried out in 1911–12 to destroy the bagworms which have proved so injurious to wattle plantations (cf. this BULLETIN, 1914, **12**, 148) have shown that this pest can be controlled by means of a parasitic fungus (*Rep. Dir. Agric. Union S. Africa*, 1912–13, p. 181). Recent experiments have been made in which the fungus was distributed by suspending from the trees fungus cultures in linen bags, through which the culture develops as soon as the climatic conditions are suitable. Results have shown that this fungoid infection of bagworms depends largely on the time of the rainfall. Early rains are favourable to the infection; but if the rains

are after the feeding time of the young bagworms, little or no infection takes place. Further trials with a modified method of propagation are being carried out this season.

Investigations are also being carried out in the Union of South Africa on the "gumming" of wattles (*Acacia mollissima*) (*loc. cit.*, p. 178.) This disease, which is prevalent in Natal, first appears as dark, sunken spots on the stem; later, cracks appear in these spots and gum exudes. If the gumming is not too severe, a cambium may form and the wound heals; but if the conditions favourable to gumming again prevail, gum may exude from the same spot. In this way the vital processes of the tree are greatly interfered with, and if the gumming continues the tree ultimately succumbs. No bacteria or fungoid organism could be isolated from the gum spots, and it would appear that the cause is probably due to some physiological disturbance. The gum forms in the phloem of the stem, the gum pockets being situated around the hard bast fibres.

The quantity of wattle bark exported from the Union of South Africa during 1913 was 65,052 tons as compared with 52,776 tons in 1912 (*Ann. Rep. Trades Commr., Union of South Africa*, 1913, p. 40). The demand for this material in the United Kingdom has remained almost stationary, but in Germany it has gradually risen owing to the increased production of leather in that country.

Enquiries made by the Trades Commissioner have shown that in order to safeguard the future of the wattle industry in Natal it is necessary that a part of the supply of bark should be manufactured into extract, so that an increased outlet for this tanning material may be found in the markets of the United Kingdom, Russia, the United States of America, and possibly France. A solid wattle extract containing 20 per cent of moisture and from 62 to 63 per cent. of tannin, it is stated, would fetch a higher price than quebracho extract.

In this respect it is interesting to note that according to the *Board of Trade Journal* (1914, **85**, 435) a company has been formed in Maritzburg for manufacturing wattle extract in solid form. It is estimated that the cost of installing the necessary plant will be £20,000 and the cost of dealing with 6,000 tons of raw material per annum £3,000.

Resins

Turpentine.—Experiments in tapping "Chil" pines (*Pinus longifolia*, Roxb.) have been continued in the Punjab (cf. this BULLETIN, 1913, **11**, 361), and have confirmed the results of the previous year, and proved that the short freshening period (*i.e.* the interval between two successive tappings) is economically sound. In future, therefore, the

four days' period, at present in vogue, will be the standard freshening period (*Prog. Rep., For. Admin., Punjab*, 1912-13, p. 11). This period has the advantage of not requiring an excessive labour supply, nor does there result a wound of inconveniently great length.

The resin factory at Shahdara (*loc. cit.*, p. 12) has been worked continuously throughout the year and dealt with 10,000 maunds (367 tons) of crude oleo-resin. It is proposed to carry on the resin industry by departmental agency until such a time as the best method for producing marketable turpentine oil and colophony has been ascertained.

Experiments have also been carried out in tapping "Kail" pines (*P. excelsa*, Wall.) in Bashahr. The results obtained were not very satisfactory, as the yield of oleo-resin was relatively small as compared with that from "Chil" pines, while the cost of extraction of the crude oleo-resin from the comparatively remote "Kail" areas of Bashahr raised the cost of production of "Kail" turpentine oil and colophony to a high figure. Accordingly these experiments have been stopped and the "Kail" areas will not be worked for the present. A small quantity of turpentine oil and colophony from this source was manufactured, and an excellent grade of turpentine oil, nearly equal in quality to the best American, was produced. An account of the results of the examination of the oil at the Imperial Institute was given in this Bulletin (1912, **10**, 544).

The results of an investigation of the oleo-resin of *P. Khasya* and *P. excelsa*, carried out at the Forest Research Institute, Dehra Dun, are given in *Indian Forest Bulletin*, No. 24, 1913. The results confirm those of previous investigations and indicate that the oil obtained from the oleo-resin of *P. Khasya* from Burma is equal in quality to high-grade French and American turpentine oils (cf. *Technical Reports and Scientific Papers, Imperial Institute*, 1903, p. 167), while the oil of this species from Assam is of inferior quality and only equal to the lower grades of American oil (cf. this Bulletin, 1912, **10**, 544). The oil of *P. excelsa* is equal to the best grades of American and French oils (*loc. cit.*). The yield of oil in the case of the *P. Khasya* oleo-resin from Burma was 17·8 per cent., and in the case of *P. excelsa* from the United Provinces 18·8 per cent. No definite information is available as to the areas covered by these two species in Assam and Burma, but the area under *P. Khasya* in Assam appears to be quite negligible. It is thought that the only part of Burma likely to prove suitable for the establishment of turpentine distilleries is the Southern Shan States; in view of the high quality of the oil yielded by the Burma pines, it is suggested that a complete economic survey of the pine area in these States should be undertaken.

Further results of the investigation which is being carried out on the possibilities of utilising the pines of Western United States of America as sources of commercial turpentine oil (cf. this BULLETIN, 1913, **11**, 361, 696) are published in the *Journ. Indust. and Eng. Chem.* (1913, **5**, 971). The oleo-resins from the single-leaf pine (*Pinus monophylla*, Torr. and Frem.) and from *Pinus Jeffreyi* have been examined as to their chemical constituents. The former gave 19·0 per cent. of volatile oil, consisting chiefly of *a*-pinene and 80·0 per cent. of colophony, while the latter yielded 88·0 per cent. of colophony and 10·0 per cent. of volatile oil, consisting mainly of normal heptane.

ECONOMIC MINERALS

Amblygonite.—In *Bulletin* No. 53, 1914, *Geological Survey of Western Australia*, T. Blatchford deals with the area embracing the Burbanks and Londonderry mining centres, and refers to an occurrence of amblygonite. The rocks of the area are largely greenstones (amphibolite, etc.) traversed by intrusions of granite and porphyrite, and dykes of pegmatite. The alluvial deposits, quartz reefs, and acid dykes of the area are auriferous. The mineral amblygonite has been mined at a locality about two miles north of Ubini, a railway siding on the Coolgardie-Perth railway. It occurs as a constituent of a dyke of pegmatite, associated with topaz, lepidolite, and beryl. It gave on analysis: phosphoric acid 48·01, alumina 34·71, lithia 9·31, fluorine 6·95, and water 2·70 per cent. Exact measurements of the dyke in which the mineral occurred were not obtainable, but it probably does not exceed a few feet in thickness. A parcel of three tons, of which a bulk sample showed 46·49 per cent. of phosphoric acid and 8·67 per cent. of lithia, was exported to Germany and sold at £8 3*s.* 11*d.* per long ton.

Bismuth Ore.—In *Bulletin* No. 14, 1913, *Geological Survey of Tasmania*, dealing with the Middlesex and Mount Claude Mining Field, W. H. Twelvetrees gives an account of the bismuth, tin, and tungsten mines of that area. The stratified rocks of the area are described as belonging to the pre-Cambrian, pre-Silurian, Silurian, Tertiary, and Quaternary. The igneous rocks include an early "porphyroid group," intrusions of granite of Devonian age, and plateau basalts of Tertiary age. It appears to be with the Devonian granites that the ore deposits are genetically connected. In this granite, and also in veins traversing the aureole of surrounding sedimentary rocks which have been metamorphosed by the intrusion, there occur ores of bismuth, tin, tungsten, and molybdenum. Various auriferous and argentiferous galena and zinc blende deposits occur still farther removed from the intrusion, and it is considered

that these represent the "hydatogenetic" phase of deposition in connection with the granite intrusion, whereas the tin-tungsten-bismuth deposits occurring in the granite and the contact zone represent the "pneumatolytic" phase.

It appears that there has not been much erosion of the ore-bearing granite and the surrounding contact zone. The Government Geologist therefore concludes that the mines are in the ideal zone for ore-deposition, and that, so far as can be ascertained on geological grounds, they have reasonable prospects in depth.

None of the mines in the district are very large, but they are being worked successfully. Their aggregate output during 1912 had a value of £15,000.

Coal.—In "Miscellaneous Reports," *Bulletin* No. 48, 1913, *Geological Survey of Western Australia*, E. S. Simpson gives the results of investigations into the composition and properties of coals from the Collie coal field. The Collie coal measures are stated by A. G. Maitland (*Bulletin* No. 50) to be of Permo-Carboniferous age. The samples examined are from seams worked at depths of from 100 to 250 feet, and the seams vary from 6 to 10 feet in thickness. The coals are described as non-caking coals of the hydrous bituminous class. Though belonging to the same general class, the coals are of two types. One of these, the "Proprietary" type, is dull and porous, dirty to handle, crumbles on exposure to the air, and burns freely without much smoke. The other, the "Collieburn" type, is bright and compact, clean to handle, burns less freely, and gives off an appreciable amount of smoke.

The mean proximate analyses of the two types of coal are as follows:

	Proprietary type. *Per cent.*	Collieburn type. *Per cent.*
Fixed carbon	48·48	40·20
Volatile matter	24·79	32·17
Moisture	18·62	23·32
Ash	8·11	4·31
Calorific value (B.T.U.)	9,695	9,516
Specific gravity	1·39	1·32

A notable feature of these coals is the high percentage of water they contain, even when quite dry to the touch and free from visible "mine-water." The whole of this water is lost when the coal is powdered and heated to 100° C. for an hour; and about a third of it is given off in a few hours when the powdered coal is left exposed to the atmosphere.

Two samples of Collieburn coal, containing when fresh 22·43 per cent. and 23·72 per cent. of moisture respectively were crushed to pass a half-inch sieve and left exposed to the air. After thirty-one days the moisture percentages

were 14·95 and 9 respectively. The moisture percentage of a sample of Proprietary coal similarly treated dropped from 19·52 to 12·25. After exposure for a month the percentage of moisture remained constant.

Gold.—*Bulletin* No. 51, 1913, *Geological Survey of Western Australia*, is Part II of a series dealing with the geology and ore deposits of Kalgoorlie and gives an account of the East Coolgardie Gold Field. Outcrops are scarce in the area dealt with, and the work of mapping has been rendered difficult by the extensive decomposition of the rocks at the surface. The oldest rocks of the area are amphibolites and talc-chlorite rocks, which have resulted from the metamorphism of dolerites and other basic types. Of somewhat later age is a quartz keratophyre, which appears to be intimately related to some of the ore bodies, and which in two localities contains free gold. It is considered too early yet to formulate any theories as to the manner of formation of the Kalgoorlie ore deposits, and the original source of the gold they contain.

In *Bulletin* No. 54, 1914, *of the Geological Survey of Western Australia*, J. T. Jutson deals with the mining geology of Ora Banda, Broad Arrow Gold Field. This mining centre is of comparatively recent growth, its development dating only from 1907. Since that time, up to the close of 1912, Ora Banda has turned out 24,336 oz. of fine gold, from 76,433 tons of ore, *i.e.* 0·32 oz. per ton. The rocks occupying the area consist of an auriferous igneous complex; but owing to the cover of laterite and superficial deposits, they are visible at the surface in only a few places. Basic rocks are represented by gabbro, dolerite, porphyrite, epidiorite, and serpentine; acid rocks by granite and quartz porphyry. The porphyrite constitutes the matrix of those ore bodies, the oxidised zones of which have been responsible for the greater part of the Ora Banda gold output. The age of the Ora Banda series is uncertain, but it is believed to be pre-Cambrian.

Other recent publications issued by the Geological Survey of Western Australia dealing with the geology of gold-mining areas are: *Bulletin* No. 49, 1913, *Geology and Mineral Resources of the Yilgarn Gold Field*, Part I, Southern Cross; *Bulletin* No. 53, 1913, already referred to in connection with amblygonite on p. 497; and *Bulletin* No. 48, 1913, in which there are various miscellaneous reports.

Iron Ore.—The Mines Branch of the Canadian Department of Mines has issued a report on "Magnetite Occurrences along the Central Ontario Railway," by E. Lindeman (*Ottawa Govt. Printing Bureau*, 1913, No. 184). The area dealt with is occupied by Archæan rocks, including gneisses, schists, and crystalline limestones, with various intrusive masses of granite, syenite, diorite, and

gabbro. The iron-ore deposits of the district are of two types, viz. (1) magnetite occurring along or near the contact of limestone and schists with various igneous rocks; (2) titaniferous magnetites associated with gabbro intrusions.

The former or contact type occurs as steeply dipping lenses, and the magnetite is associated with pyroxene, amphibole, epidote, garnet, and calcite. The best quality of this type of ore averages about 54 per cent of metallic iron, but there would apparently be some difficulty in maintaining an output of ore at that standard; and a large proportion of the ore available does not contain more than 30 to 45 per cent. of metallic ore. Sulphur is high as a rule, owing to the presence of iron pyrites, and occasionally pyrrhotite. Phosphorus varies from 0·018 to 0·20 per cent.

The second type of deposit, consisting of segregations of titaniferous magnetite in gabbros, is too titaniferous to be of much value. Two occurrences that were examined gave samples containing 10 per cent. and 15·31 per cent. of titanium respectively. This fact, together with the irregularity and uncertain extent of the deposits, makes them of little or no economic importance.

Monazite.—According to E. S. Simpson (*Miscellaneous Reports, Bulletin* No. 48, 1913, *Geological Survey of Western Australia*), monazite occurs associated with cassiterite and columbite in the alluvial deposits at Cooglegong and Moolyella. A sample of 100 lb. from Cooglegong consisted of small pebbles weighing from 0·1 to over 10 grams. The Moolyella material so far obtained has been got by re-sluicing low-grade tin gravels, one of the products thus obtained being a high-grade tin ore, the other product containing, in one sample that was examined, 26·2 per cent. of monazite, 26·3 per cent. of cassiterite, 46·5 per cent. of columbite, and 1 per cent of garnet.

An analysis of picked monazite from these two localities showed the following composition:

		Cooglegong sp. gr. 5·3. *Per cent.*	Moolyella sp. gr. 5·26. *Per cent.*
Cerium oxide	Ce_2O_3	31·10	33·06
Lanthanum oxide / Didymium oxide	La_2O_3 / Di_2O_3	34·26	30·21
Yttrium oxide	Y_2O_3	0·04	0·14
Thoria	ThO_2	3·80	5·03
Ferric oxide	Fe_2O_3	0·42	2·21
Alumina	Al_2O_3	0·64	0·44
Lime	CaO	0·34	0·90
Magnesia	MgO	trace	0·21
Lead oxide	PbO	trace	trace
Phosphoric oxide	P_2O_5	26·89	26·70
Silica	SiO_2	1·96	1·22
Water	H_2O	0·58	0·59

The Moolyella mineral is darker and richer in thoria than the Cooglegong mineral, but so far as is known at present it occurs in smaller quantities.

Further search for alluvial deposits and pegmatite veins is recommended.

Radio-active Minerals.—Included in "Miscellaneous Reports," *Bulletin* No. 48, 1913, *Geological Survey of Western Australia*, is an account of the radio-active minerals occurring at Wodgina. The minerals referred to as occurring in notable quantities are hydrated silicates of uranium, thorium, and lead, and are described under the names of mackintoshite, thorogummite, and pilbarite. They occur as constituents of the "main tantalite lode" at Wodgina, near the western boundary of the Pilbara gold field. The predominant rocks of the area are "greenstone schists," and these are penetrated by numerous veins of pegmatite, one of which is the "main tantalite lode" containing tantalite, cassiterite, and the radio-active minerals already referred to. The portion of the pegmatite vein carrying the radio-active minerals has a width of about 30 ft. A cross cut at 70 ft. showed that the middle 15 ft. of the vein consisted of albite and quartz, and was devoid of metallic minerals. On either side of this was a band, 5 ft. or so in width, of coarse albite carrying a little quartz, dark mica, tantalite, and radio-active minerals, the band on the foot-wall side being stated to contain a larger quantity of tantalite and radio-active minerals than the band on the hanging wall side. Against the hanging wall were a few inches of a strongly foliated mixture of chlorite and biotite.

Practically the whole of the tantalite output of Wodgina has been obtained from the "main tantalite lode" or from the surface fragments weathered out of it.

The General Report of the Director of the Geological Survey of India for 1913 (*Rec. Geol. Surv. India*, 1914, **44**, Part I) includes a brief report by R. C. Burton on an occurrence of pitchblende at mica mines near Singar, Gaya district, Bengal. The pitchblende occurs as rounded nodules in a pegmatite that is intrusive in mica schists. Other minerals occurring in the pegmatite are mica, triplite, ilmenite, tourmaline, and uranium ochre; whitish columbite, zircon, and torbernite have also been recorded. Of these minerials triplite is stated to be the commonest. It is associated so persistently with the pitchblende and uranium ochre that its presence is taken as an indication of the presence of these minerals. Many of the pitchblende nodules occur in a matrix of triplite; some occur in a felspathic matrix. One nodule of pitchblende weighing 36 lb. has been obtained. The pegmatite has been mined for many years for mica. As yet, not much pitchblende has been

obtained; but one pit has yielded up to the present about 4 cwts. of the mineral.

Tin Ore.—In his *Annual Report* for the year 1913 (*Fed. Malay States Govt. Gaz.*, March 27, 1914), the Geologist of the Federated Malay States gives a brief account of the tin deposits of Gunong Bakau, a mountain (4,426 ft.) on the Selangor-Pahang Boundary about ten miles from Peretah. This mountain consists of granite which is traversed by two different types of stanniferous deposits. The older of these is a quartz-topaz rock, occurring in veins which reach a thickness of 15 ft. The younger is a topaz-aplite, occurring partly in the form of veins and partly in the form of masses, which cut both the granite and the veins of quartz-topaz rock. Although cassiterite occurs disseminated in both types, it does not occur abundantly enough in the aplite to make this of value as tin ore, except at one place. The quartz-topaz rock, on the other hand, is richer in cassiterite. It contains as much as 9 per cent. in some cases, and at one quarry where it has been opened up the rock contains about 1·75 per cent. of cassiterite. The quartz-topaz veins are found outcropping all round the mountain, and at one locality a drive has been made into the hill along one of these veins for a distance of 300 ft.

NOTICES OF RECENT LITERATURE

The Wilds of Maoriland. By James Mackintosh Bell, M.A., Ph.D. Pp. xiii + 257, Med. 8vo. (London: Macmillan & Co., 1914.) Price 15*s.*; post free, United Kingdom 15*s.* 5*d.*, abroad 15*s.* 10*d.*

The author, who was formerly Director of the Geological Survey of New Zealand, describes his travels off the beaten track in the New Zealand "back country." Only a few enthusiastic travellers have yet wandered from the paths of civilisation into the Alpine valleys or scaled the snow-clad peaks which look down upon the plains of Canterbury and the forests of Westland, while the fiord region of the south-west of the South Island still remains almost a *terra incognita*. In a chapter headed "From Whangaroa to the North Cape" we have a description of the Auckland Peninsula. To its shores came some of the first white settlers in Maoriland during the early part of the last century. Another section of the book describes the author's rambles in "The Hauraki Goldfields." There is an interesting account of the volcanic area, followed by a chapter on the Urewera Country, which occupies the heart of the eastern peninsula of the North Island, and is the last stronghold of the Maori. The rest of the book is mainly devoted to a description of the Southern Alps

and the Great Douglas Glacier, concluding with a general sketch of the geography and climate of New Zealand. The book is illustrated by excellent photographs and coloured reproductions of characteristic scenery.

New Zealand: Its History, Commerce, and Industrial Resources. Compiled by Somerset Playne, F.R.G.S., assisted by J. W. Bond and H. H. F. Stockley, F.R.G.S. Edited by F. Holderness Gale. Pp. 699, Roy. 4to (London: Foreign and Colonial Compiling and Publishing Co., 1912–13). Price, 25*s.* net; post free United Kingdom, 25*s.* 9*d.*

This attractive volume is one of a series treating of outlying portions of the Empire, and it follows three books of similar style dealing respectively with British East Africa and Uganda, Cape Province, and the Orange Free State. Its general purpose is to give a complete literary and pictorial survey of the commercial, industrial, and agricultural resources of the territory dealt with, together with an account of the notable physical features of the country and also of its social side. The opening chapters describe the early history of the Dominion and the Maori race, and beside the topographical matter there are contributions by experts on the flora, climate and rainfall, geology, sport, and the dairying industry, which add considerably to the usefulness of the publication. There are over 2,000 photographs depicting New Zealand life in its many social and industrial activities as well as the beauties of the scenery.

La Géographie de Terre-Neuve. By M. Robert Perret. With a preface by M. Marcel Dubois. Pp. vi + 372, Med. 8vo. (Paris: E. Guilmote, 1913.) Price 10 francs; post free, United Kingdom 8*s.* 5*d.*, abroad 9*s.*

Dr. Perret is to be congratulated on having produced a most comprehensive and scientific account of the geography of Newfoundland. As a proof of the painstaking and detailed manner in which he has dealt with the subject, it may be mentioned that the number of books and papers referred to amounts to no less than 406, in addition to a number of periodical publications and a large series of maps. As a result of his researches many gaps in our knowledge of the history of the island have been filled up. The opening chapter of the book deals with the history of exploration in the island, including an account of the visits of the earlier navigators, and is illustrated by reproductions of the maps of Sebastian Cabot (1544) and Pierre Bertius (1606). Subsequent chapters deal with the geology and physical features of the island, the oceanography of the Newfoundland Banks, the climate, the flora, and the fauna of land and sea. Two chapters are devoted to

the chief industries of the Colony; one deals with agriculture, the wood pulp industry and the mineral resources, and the other gives a detailed account of the sea-fisheries—by far the most important of the Newfoundland industries. The concluding chapters deal with the history of colonisation of the island, and its relations with the powers.

The book is well illustrated with maps and reproductions from photographs, but a regrettable feature is the absence of an index; the only indication of the subject matter is a contents list which consists merely of the titles of the chapters.

Industrial and Commercial Geography. By J. Russell Smith. Pp. xi + 914, Demy 8vo. (London: Constable & Co., Ltd., 1914.) Price 15*s*. net.; post free, United Kingdom 15*s*. 6*d*., abroad 15*s*. 10*d*.

Prof. Russell Smith begins his preface to this book with the sentence, "This book aims to interpret the earth in terms of its usefulness to humanity." That statement usefully indicates the wide scope of his subject as conceived by the geographer of modern times, and proclaims the very important part which geography should take in present-day education of all grades.

The author divides his subject into two parts. The first of these deals in seventeen chapters with the nature and the regional distribution of the great industries of the world. As an example of his method, the chapter on "Condiments and Tobacco" may be referred to more particularly. This chapter deals with coffee, tea, cacao, spices, and tobacco. Each of these products is discussed in turn, the factors influencing the location of the particular crop, the preparation of the produce for the market; the chief features of its production in the principal areas and statistics of production and consumption, being the usual sections into which the discussion is divided. No exception need be taken to this arrangement, but the author goes into unnecessary detail and as a result makes mistakes on technical points. A few of these may be mentioned. Under Formosa (p. 300) it is stated that "the best tea in the world is grown by Chinese people in the island of Formosa." It is quite true that the finest qualities of tea produced in Formosa have a delicacy and aroma which distinguish them from all other teas, but that does not make Formosa tea the best in the world. On p. 296 the following statement occurs: "Little oil cells give the leaf [*i.e.* the tea leaf] its flavour, while the stimulating quality comes from a substance called theine, which is almost exactly the same as the caffeine of the coffee and the stimulating principle in cocoa or chocolate." The flavour of tea is not due to the oil cells, though it is *partly* due to their contents, and theine is not merely "almost exactly

the same as caffeine," but is caffeine, practically all the caffeine made being extracted from waste tea. Under "cacao" (p. 307) it is asserted that "when carefully fermented the seeds [*i.e.* cocoa beans] are twice as valuable as when carelessly done." That may have been the case at one time, but the fact that unfermented cocoa now fetches almost as good a price as fermented cocoa is one of the most serious difficulties in the way of effecting an improvement in the quality of cocoa produced in West Africa. A much more serious mistake, however, is the fact that there is no reference whatever to the Gold Coast Colony in the section of the book devoted to cocoa, although that Colony is now the largest producer of cocoa in the world, and the industry there presents features of special interest from the point of view of those interested in economic and industrial geography.

Under the heading "Spices" it is stated (p. 310) that "the best preserved ginger is exported from South America, West Africa, Bengal, Cochin China, and, to a small extent, from North Queensland." The use of the term "preserved" is a little unfortunate here, as "preserved" ginger usually means ginger preserved in syrup, a commodity obtained almost entirely from China. The author appears to use "preserved" as synonymous with "prepared"; but even in this sense the statement is inaccurate, since the best prepared ginger comes from Jamaica and the Cochin district of India (not Cochin China), that from West Africa being almost the worst on the market. Under the heading "Vanilla" it is asserted (p. 311) that "the manufacture of vanillin, a substitute produced from sugar by electrolysis, threatens this industry" [*i.e.* the vanilla industry]. Vanillin is not made from sugar, but from eugenol, the chief constituent of clove oil. The introduction of vanillin certainly seriously affected the vanilla industry, causing a great fall in the prices obtained for vanilla, but there is good reason to believe that in recent years the consumption of vanilla has not seriously declined, and it seems probable that for many purposes vanilla cannot be substituted by vanillin. The section on spices is incomplete, there being no reference to caraway seed, cardamoms, aniseed, and other products largely used in the liqueur industry. The title of this chapter, "Condiments and Tobacco," is misleading, since the stimulant foodstuffs, cocoa, coffee, and tea, can hardly be called condiments, though this term might perhaps be used to include the spices.

The second part of the book deals with commercial geography in sixteen chapters. The first chapter discusses the law of trade, the next ten the various ocean routes, and the remainder deal with special subjects, such as the influence of the Panama Canal on ocean transport, the development and work of the trade centres of the world,

the balance of trade, and lastly the influence of geographic factors on the commercial policy of nations. All these subjects are well and clearly discussed, and this part of the books seems to be fairly free from errors of technical detail, which, as already indicated, are somewhat conspicuous in some portions of the first part.

The book contains a large number of illustrations, maps, graphs, and statistical diagrams.

Indian Cotton. By Arno Schmidt, Secretary to the International Federation of Master Cotton Spinners' and Manufacturers' Associations. Report on his Third Visit to India, October 1913—February 1914. Pp. 260, Roy. 8vo. (Manchester, 1914.)

This work contains an account of investigations made by the author during three visits to India, which he made with a view to studying the cultivation of cotton in that country, and also records the conclusions he has drawn with reference to the improvement of Indian cotton and the extension of the area devoted to the crop.

This book is divided into four parts. The first consists of a series of notes on the geography of the country, its administration, the organisation of the Agricultural Departments, the agricultural conditions, irrigation, the caste system, village systems, and land revenue and tenure. In the second part an outline is given of the history of cotton growing in India, together with statistics of the crops and the methods of handling and marketing the produce. The third part, which constitutes the greater part of the book, gives a detailed account of the conditions of the industry, the methods of cultivation adopted, and the varieties of cotton grown in each of the Provinces; whilst the fourth part deals briefly with the principal Indian industries, and especially with that of cotton manufacture. In an appendix statistical tables are provided showing the area under cotton, and the yield and exports in the different Provinces during the years 1902–3 to 1911–12, together with a glossary of Indian words and other information.

The work is provided with maps and numerous illustrations, and forms a useful memoir on the cultivation, utilisation, and commerce of Indian cotton.

Culture et Exploitation du Caoutchouc au Brésil. By O. Labroy and V. Cayla. Pp. 235, Imper. 8vo. (Paris: Société Générale d'Impression, 1913.)

This work is divided into five parts. Part I deals with general considerations of the rubber industry in Brazil and other parts of the world; Part II is devoted to *Hevea brasiliensis*; while Parts III, IV, and V deal respectively with *Manihot* species, *Castilloa* and "Mangabeira" (*Hancornia speciosa*). As one would expect, prominence is given

to Hevea rubber, nearly half the space being allotted to this important subject. The book furnishes a most useful résumé of the knowledge of the above-mentioned sources of rubber in Brazil, and also deals briefly with the various aspects of the rubber-planting industry in the Middle East and elsewhere. In each case the nature of the tree, its cultivation, the collection of latex and preparation of rubber, etc., are discussed; but it is obvious that a subject of such scope can only be dealt with briefly in a book of this size. The authors have drawn largely on the information of previous workers, and a very large amount of information previously scattered now becomes readily available. The value of this work would have been greater if more frequent references to sources of information had been given. There are numerous illustrations, many of which are reproductions from photographs.

Date Growing in the Old World and the New. By Paul B. Popenoe, with a chapter on the food value of the date by Charles L. Bennett, M.D. Pp. xviii+316, Demy 8vo. (West India Gardens, Altadena, California, U.S.A., 1913.) Price $2 net; post free, United Kingdom 8*s.* 9*d.*, abroad 9*s.* 1*d.*

Careful experimental work on the cultivation of the date palm has been carried on for many years by the United States Department of Agriculture, and has led to such successful results that, during the last two or three years, commercial planting has been undertaken on a large and steadily increasing scale. The date palm is capable of withstanding a certain amount of frost, but it requires a long, dry, and hot season to enable the fruit to ripen satisfactorily. For this reason the cultivation in the United States is necessarily limited to a small territory in the "desert region" of Southern California and Arizona. In this area it has been found possible to reproduce the conditions under which the date palm grows in the oases of North Africa and Arabia. The Coachella and Imperial Valleys of California and some parts of Arizona have proved well adapted to date cultivation. It is stated that the American-grown date is superior to the Old World product in both size and flavour.

The author of the work under consideration has spent two years in studying the subject in the most famous date-growing regions of the Orient, and has also had considerable experience of the cultural methods adopted in the United States, and has therefore been able to collect a large amount of information. The book deals with every phase of date cultivation, including the propagation of the palm, irrigation, manuring, pollination, artificial ripening, harvesting, and packing the crop for the market. One chapter is devoted to the diseases and pests by which

the palm is liable to be attacked, and measures for controlling them are indicated. A description is given of ninety of the most important varieties of dates in the United States.

The book is written in an interesting manner, contains a number of excellent illustrations, and will doubtless be of great value to all date growers, and especially those of the United States.

Field Crop Production. By George Livingston, Assistant Professor of Agronomy, Ohio State University. Pp. xix+424, Crown 8vo. (New York: The Macmillan Company, 1914.) Price 6*s.* net; post free, United Kingdom 6*s.* 5*d.*, abroad 6*s.* 9*d.*

In this book the author describes the standard cereal, legume, root, grass, clover, and fibre crops, and the way they are grown and harvested. This is done simply and clearly, avoiding the numerous tables of figures and discussions on the merits of different manurial treatments, which, although very valuable for more advanced students, make exhaustive treatises on agriculture heavy reading for beginners. As it is written in the United States, maize receives a good deal of attention. Some account is given of seed testing and of the insect and fungoid enemies of the crops.

There are numerous illustrations, and the author has been very successful in the choice of the information imparted and the way it is presented. The book is intended to serve as a general text-book of field crops in elementary courses, and as a supplementary text-book in other courses, for students with little or no elementary knowledge of the subject, and thus to supplement the instruction given by the lecturer.

Filters and Filter Presses for the Separation of Liquids and Solids. From the German of F. A. Bühler. With additional matter relating to the theory of filtration, and filtration in sugar factories and refineries by John Joseph Eastick, F.I.C., A.R.S.M. Pp. viii+184, Roy. 8vo. (London: Norman Rodger, 1914.) Price 12*s.* net; post free, United Kingdom 12*s.* 4*d.*, abroad 12*s.* 8*d.*

An enormous variety of appliances, apparatus, and machinery is employed in industry for the purpose of separating solids and liquids. In the volume under notice the most useful of these are classified and described. The first part of the work is devoted to the various classes of filters, and the second to the presses used for separating solids and liquids, whilst in the third part an account is given of the theory of filtration and its practical application in the sugar industry. Following this is a collection of abridged specifications of sundry filter-press

patents and a list of United Kingdom patents relating to filters and filtering apparatus. The matter is well arranged and fully illustrated, and the book should prove of great service in the numerous industries in which processes of filtration are employed.

THE FIXATION OF ATMOSPHERIC NITROGEN. By Joseph Knox, D.Sc. (Chemical Monographs Series, No. 4). Pp. iv +112, Crown 8vo. (London: Gurney & Jackson, 1914.) Price 2*s.* net; post free, United Kingdom 2*s.* 3*d.*; abroad 2*s.* 4*d.*

Until comparatively recently almost the only sources of the nitrogen compounds required for the chemical industries and for artificial manures were the sodium nitrate deposits of Chili and the ammonia and ammonium compounds produced by the destructive distillation of coal. The Chilian deposits would soon be exhausted if the present rate of consumption should continue, and the products obtained from coal would not be nearly sufficient to supply the demands of the chemical industries and agriculture. Fortunately, however, there is an inexhaustible supply of nitrogen in the atmosphere, and during the last few years a great deal of work has been done on the conversion of this into technically important nitrogen compounds, especially nitrates and ammonium compounds.

The present monograph gives a useful account of the chief discoveries which have been made in this connection. The methods and processes employed are considered under three main headings: (1) fixation of atmospheric nitrogen as nitric and nitrous acids or their salts; (2) synthesis of ammonia and ammonium compounds from atmospheric nitrogen; and (3) conversion of atmospheric nitrogen into compounds which readily yield ammonia. Each chapter deals first with the chemical reactions involved, and subsequently with their technical application on the manufacturing scale. The value of the book is greatly enhanced by the numerous references to the original literature of the subject.

IGNEOUS ROCKS AND THEIR ORIGIN. By R. A. Daly. Pp. xxii+563, Med. 8vo. (London: Hill Publishing Company, 1914.) Price 17*s.* net; post free, United Kingdom 17*s.* 5*d.*, abroad 17*s.* 11*d.*

The scope of this book is well described by the author as follows: "The book is intended to summarise and correlate the facts known about igneous rocks, with special emphasis on their field relations. Knowledge of petrography and a moderate acquaintance with the physics and chemistry of rock-melts are assumed, but the treatment of the subject is essentially geological. The work is divided into three parts. The first of these (Chapters II to VII

inclusive) broadly considers the facts which need explanation in a philosophy of the igneous rocks. The second part (Chapters VIII to XIV inclusive) contains a general eclectic theory on the subject. The third (Chapters XV to XXII inclusive) outlines the results of applying the general theory to the facts so far determined."

Prof. Daly's attitude of mind towards igneous problems is strongly expressed in the introduction, in which he remarks: "What geology, like every other science, needs to-day is a frank recognition that imaginative thought is not dangerous to science, but is the life-blood of science. . . . Science is built on a long succession of mistakes. . . . Progress, indefinitely more rapid, will be possible when men of science have more generally lost the fear of making mistakes in using to the uttermost their powers of correlation and deduction. . . . Science is drowning in facts."

Opinions will differ as to the soundness of this doctrine. There can be no doubt that the petrology of igneous rocks offers fine scope for imaginative work; and in this book Prof. Daly has written in strict accordance with the doctrine he enunciates in the introduction. He draws pretty fully on imaginative thought, but he leaves the critical reader wondering whether, after all, such a liberal use of the imagination is not perhaps liable to be a little dangerous to science. It can, of course, be dangerous only to those who lack the knowledge and ability to distinguish facts from interpretations.

It is one of the drawbacks of igneous petrology that facts of a certain kind concerning it are multitudinous, whilst the definitely established theories are few—so much is this the case that cautiously written treatises on the subject are apt to be too stodgy. Prof. Daly has tried to avoid this by coupling the facts on to hypotheses which, though not yet definitely established, are very interesting. His views are stimulating to the critical reader, and his book is excellently adapted for the use of advanced students who know sufficient of the facts and prevailing conceptions of petrology to be able to appraise at their proper value some of the interpretations which the author sets forth.

The book is one that is well worthy of study by all serious students of petrology; it cannot fail to stimulate thought and research; and, indeed, no one who wishes to understand some of the most important hypotheses connected with the origin of igneous rocks can afford to leave the book unread.

MANUAL OF PETROGRAPHIC METHODS. By A. Johannsen. Pp. xxviii + 649, Med. 8vo. (London: The Hill Publishing Company, 1914.) Price 25*s.* net; post free, United Kingdom 25*s.* 6*d.*, abroad 26*s.* 1*d.*

This book deals comprehensively with physical methods in petrography from the standpoint of the laboratory worker. It represents a large amount of labour in the reading and abstracting of the numerous scientific papers that are referred to; and students of petrography owe a debt to the author for having made this extensive compilation from widely scattered sources.

Optical methods bearing on the use of the polarising microscope and its accessories naturally claim a preponderance of space. The treatment of the subject is rather more academical than practical. The reverse of this would have been preferable, seeing that the book appears to aim chiefly at being a laboratory guide. Some matters are dealt with at much greater length than is necessary. As an instance of this, the long account of different types of polarising microscopes may be mentioned. On the other hand, in dealing with the examination of opaque minerals, although the author admits its practical importance, he states that the book is too limited in scope to deal with these methods, and merely gives a list of papers. The student with a practical turn of mind will have some regret that the author did not choose to give an account of this part of the subject, even if in so doing he had found it necessary to save space in dealing with some items of less practical importance.

As regards other physical methods one notes defects in the account of magnetic separation. The author follows certain other writers in attributing to Fouqué the credit, which really belongs to Delesse, of introducing the electro-magnet in the examination of rocks. Moreover, the type of pole-pieces described in this book has long been superseded. No reference is made to the electrostatic method of mineral separation, a method which at times proves very useful in the laboratory.

A chapter is given to microchemical reactions; but it seems strange to an English reader to see the familiar staining tests for distinguishing certain minerals described as tests for the "separation" of these minerals (pp. 565–8). There is also a chapter on the preparation of sections and another on petrographic collections. An appendix comprises the Greek alphabet, some mathematical formulæ and tables, and some useful recipes.

The book is likely to prove very useful for study and reference among students of petrography.

Das Aufsuchen und die Untersuchung von Lagerstätten nutzbarer Mineralien in den Tropen. By O. Mann. Pp. v + 92, Demy 8vo. (Hamburg: Fr. W. Thaden.) Price 2.80 marks; post free, United Kingdom and abroad 3*s.* 1*d.*

This little book is intended as a simple guide to pro-

specting, for the use of officers, merchants, and planters in the tropics. The author is the Government Geologist of Togoland, formerly of Kamerun. In the first thirty-four pages is given a simple account of the equipment required by the prospector, a brief account of the commoner types of rocks and ore deposits, and a short practical description of prospecting methods. The remainder of the book is devoted chiefly to a description of the commoner ores and other useful minerals, and there is an appendix dealing with mining law in German Protectorates.

The simplicity of treatment gives the book an attractive appearance from the standpoint of the untrained prospector. A closer examination shows, however, that the author has not made a thorough study of the subject. As examples of erroneous teaching the following extracts may be quoted:

"Meist ist der Monazit recht schwer in dem Sand zu erkennen. Sicher feststellen kann man ihn nur mit Hilfe eines Spektroskopes" (p. 70).

"Kalk- und Kupferuranglimmer, die grünliche, glänzende Tafeln bilden, haben keine praktische Bedeutung" (p. 72).

"Unter den verschiedenen Glimmerarten hat nur der Muskovit praktische Bedeutung" (p. 82).

In fact, the book is not only inaccurate in many of its details; it is also defective in scope. It leaves unmentioned many important useful minerals; it does not give sufficient information to enable minerals to be identified; and it says little or nothing about the distribution of useful minerals. Hence, attractive as the book is in some respects, it is not to be trusted as a guide, and will require considerable revision and enlargement before it can be recommended for use.

The London Chamber of Commerce from 1881 to 1914. By Charles E. Musgrave. Pp. viii + 93, 8vo. (London: Effingham Wilson, 1914.) Price 2*s.* 6*d.* net; post free, United Kingdom 2*s.* 10*d.*, abroad 2*s.* 11*d.*

In this little book the Secretary of the London Chamber of Commerce gives a most interesting account of the growth and activities of the Chamber since it was formed in October 1881. In the first complete year of its existence it had 1,386 members, and an income of £3,215, whilst in 1913 its membership was 5,265 and its income £29,079. During the thirty-three years of its existence the Chamber has taken a leading part in organising commercial education, promoting commercial arbitration and labour conciliation schemes, and in encouraging Imperial commerce, to mention only a few of its more striking activities. At the same time, especially by means of its numerous trade sections, it has been able to render great assistance to the large number of trades carried on in and around London.

The membership figures quoted above prove that the Chamber has already secured a large body of support from the commercial community in London. Mr. Musgrave's account of the work of the Chamber shows that this support is well deserved, and it is to be hoped that its publication will still further extend the interest shown by London merchants and manufacturers in the work of the Chamber.

HANDBOEK VOOR CULTUUR-EN HANDELSONDERNEMINGEN IN NEDERLANDSCH - INDIË, 1914. Pp. x + 1655, Med. 8vo. (Amsterdam: J. H. de Bussy, 1913.) Price 10 florins; post free, United Kingdom 17*s.* 2*d.*, abroad 18*s.* 1*d.*

This excellent handbook, which has now reached the twentieth year of publication, should prove of great value to all interested in the agricultural and mining industries of the Dutch East Indies. Particulars are given of all plantations in the islands, including in most cases their output for a number of years. Next follows a directory of business houses arranged under the names of the towns in which they are situated. A large section of the book is devoted to accounts of the various joint-stock, trading, plantation, mining, and other companies connected with the Dutch East Indies, as well as of local associations and societies. Various laws and regulations at present in force are given, including those relating to concessions, the exploitation of forests, coolie labour, the cultivation of various crops, the importation of cattle, and mining and prospecting. Particulars are also furnished as to certain taxes and duties, and amongst other useful information there is a list of tariffs and a detailed list of all imported and exported articles showing the standard prices on which port dues are assessed.

BOOKS RECEIVED

ANGLO-EGYPTIAN SUDAN HANDBOOK SERIES. 1. "The Bahr El Ghazal Province." Pp. 164. 2. "Kordofan and the Region to the West of the White Nile." Pp. 215. Compiled in the Intelligence Department, Sudan Government, Khartoum. (London: H.M. Stationery Office, 1911 and 1912.)

LAITE'S COMMERCIAL BLUE BOOK FOR SOUTH AFRICA, 1914. Compiled and edited by W. J. Laite. Pp. 591. (Cape Town: South African Publishers, Ltd., 1914.) Price 3*s.* 6*d.* net; post free, United Kingdom 3*s.* 11*d.*; abroad 4*s.* 3*d.*

Rutherford's Planters' Note Book. 6th Ed. Pp. lxix + 478. (Colombo and London: Times of Ceylon Company, 1914.) Price 20*s.*; post free, United Kingdom 20*s.* 5*d.*, abroad 20*s.* 10*d.*

Indian Forest Insects of Economic Importance. Coleoptera. By Edward Percy Stebbing. Pp. xvi + 648 + 64 plates. (London: Eyre & Spottiswoode, Ltd., 1914.) Price 15*s.*; post free, United Kingdom, 15*s.* 7*d.*

Practical Tropical Sanitation. By W. Alex. Muirhead. Pp. xv + 288. (London: John Murray, 1914.) Price 10*s.* 6*d.* net; post free, United Kingdom 10*s.* 10*d.*, abroad 11*s.* 2*d.*

Phillips's Paper Trade Directory of the World, 1913–14. By S. Chas. Phillips. Pp. lxxx + 850. (London: S. C. Phillips & Co.) Price 15*s.* 6*d.*; post free, United Kingdom 16*s.*, abroad 16*s.* 8*d.*

Mining World Index of Current Literature. Vol. V, January–June 1914. By Geo. E. Sisley. Pp. xxix + 237. (Chicago: The Mining World Company, 1914.) Price $2; post free, United Kingdom 8*s.* 8*d.*, abroad 8*s.* 11*d.*

Why we are at War. Great Britain's Case. By Members of the Oxford Faculty of Modern History. Pp. 206. (Oxford: Clarendon Press, 1914.) Price 2*s.* net; post free, United Kingdom 2*s.* 4*d.*, abroad 2*s.* 5*d.*

India and the War. By Sir Ernest J. Trevelyan. Pp. 11. (London: Oxford University Press, 1914.) Price 1*d.* net; post free, United Kingdom and abroad, 1½*d.*

The War and the Dominions. By H. E. Egerton. Pp. 23. (London: Oxford University Press, 1914.) Price 2*d.* net; post free, United Kingdom and abroad, 3*d.*

LEGISLATIVE LIBRARY ONTARIO

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial, Indian, and other Governments concerned.

SOILS FROM THE EAST AFRICA PROTECTORATE

At the Third International Congress of Tropical Agriculture, held at the Imperial Institute in June last, Mr. Harcourt, Secretary of State for the Colonies, drew attention to the possibility of utilising the land bordering on the Juba River in East Africa, for the cultivation of cotton and other tropical products. This could be done by erecting barrages and constructing irrigation works. The matter also formed the subject of a paper by Dr. N. M. Alemanni, read before the same Congress. Experiments in cotton growing in this region have been undertaken already on behalf of the Department of Agriculture of the Protectorate, and certain areas have been irrigated by canals. The results of the experiments have been quite successful, and a yield of 1,800 lb. of seed-cotton per acre was obtained at Halwalood in 1911–12. A knowledge of the character of the soil in this region is of considerable importance in this connection, and a number of samples obtained from the British side of the river have been examined at the Imperial Institute in recent years. Analyses of some of these have already been published in this Bulletin (1912, **10**, 416), and in the following pages an account is given of the results of examination of twenty-four soils collected at Gosha, Jubaland.

Each sample was submitted to (1) a mechanical analysis

and (2) a chemical analysis. In two cases (Nos. 1 and 2) the mechanical analysis was performed on the entire soil, which was air-dried before examination, but the remaining samples contained varying amounts of calcium carbonate (in the form of lumps, fine particles, or small shells) which was removed by treatment with dilute acid before the mechanical analysis was performed; the results in these, as in all other cases, are expressed on the entire soil. The chemical analysis was performed on the portion of soil passing a 1 mm. sieve; the figures giving the "available" constituents in pounds per acre were calculated in each case for a depth of 9 in., the apparent specific gravity of the soil being taken into consideration.

No. 1.—"Collected on Halwalood Plain about 400 yards from the Juba River, and about 100 yards north of the main irrigation canal." This was a sample of clay soil.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
3·80	3·80	8·55	71·93	11·82	0·10[1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (Cl), *sulphates equal to* 0·02 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·04 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	1·74	—	—
Magnesia	MgO	—	2·35	—	—
Potash	K_2O	—	1·05	0·01	268
Ferric oxide	Fe_2O_3	—	8·84	—	—
Phosphoric acid	P_2O_5	—	0·15	0·03	804
Nitrogen	N	0·06[1]	—	—	—
Carbon dioxide	CO_2	0·55	—	—	—
Loss on ignition		19·91	—	—	—
Humus		0·51[2]	—	—	—

[1] *Equivalent to* 1,609 *lb. per acre.* [2] *Containing nitrogen* 3·1 *per cent.*

This soil contains adequate supplies of mineral plant

food constituents. The percentage of nitrogen present is low, and the soil would benefit by "green manuring." Owing to the quantity of sodium carbonate present, the soil would not be suitable for the cultivation of crops which are specially sensitive to this constituent.

No. 2.—"Collected at the base of salt bushes, about 100 yards west of spot from which preceding sample (No. 1) was taken." This was also a sample of clay soil.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
2·45	3·23	9·65	74·95	9·47	0·25 [1]

[1] *Including chlorides equivalent to* 0·05 *per cent. of chlorine* (Cl), *sulphates equivalent to* 0·02 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·11 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	2·36	—	—
Magnesia	MgO	—	2·51	—	—
Potash	K_2O	—	0·97	0·02	553
Ferric oxide	Fe_2O_3	—	8·96	—	—
Phosphoric acid	P_2O_5	—	0·17	0·05	1,381
Nitrogen	N	0·06 [1]	—	—	—
Carbon dioxide	CO_2	1·13	—	—	—
Loss on ignition		19·64	—	—	—
Humus		0·80 [2]	—	—	—

[1] *Equivalent to* 1,658 *lb. per acre.* [2] *Containing nitrogen* 2·5 *per cent.*

This soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen is low. The soil contains too much alkali, and is of a type upon which none but alkali-resistant crops will grow.

No. 3.—"Collected on Halwalood Plain, about 300 yards west of the clump of salt bushes referred to under sample No. 2." This also was a clay soil. It contained 1·32 per cent. of calcium carbonate ($CaCO_3$), in the form of lumps and finely disseminated particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
3·50	4·34	11·39	66·93	12·28	0·24 [1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (Cl), *sulphates equivalent to* 0·05 *per cent of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·05 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	2·26	—	—
Magnesia	MgO	—	3·02	—	—
Potash	K_2O	—	1·07	0·012	293
Ferric oxide	Fe_2O_3	—	5·77	—	—
Phosphoric acid	P_2O_5	—	0·11	0·021	512
Nitrogen	N	0·07 [1]	—	—	—
Carbon dioxide	CO_2	0·58	—	—	—
Loss on ignition		20·22	—	—	—
Humus		0·87 [2]	—	—	—

[1] *Equivalent to* 1,707 *lb. per acre.* [2] *Containing nitrogen* 3·45 *per cent.*

This soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen present is low. The soil would probably benefit by "green manuring." It appears to contain too much alkali salt to be used for the cultivation of many of the common crops.

No. 4.—"Collected on Halwalood Plain from a plot which had been under cotton." This soil was a highly calcareous clay. It contained 12·41 per cent. of calcium carbonate ($CaCO_3$) in the form of finely disseminated particles, lumps, and small shells.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	4·20	22·30	51·63	9·27	0·19 [1]

[1] *Including chlorides equivalent to* 0·006 *per cent. chlorine* (Cl), *sulphates equivalent to* 0·05 *per cent. sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·02 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	7·65	—	—
Magnesia MgO	—	2·66	—	—
Potash K_2O	—	0·88	0·021	554
Ferric oxide Fe_2O_3	—	4·98	—	—
Phosphoric acid P_2O_5	—	0·11	0·033	871
Nitrogen N	0·08 [1]	—	—	—
Carbon dioxide CO_2	5·46	—	—	—
Loss on ignition	21·68	—	—	—
Humus	0·68 [2]	—	—	—

[1] *Equivalent to* 2,113 *lb. per acre.* [2] *Containing nitrogen* 7·35 *per cent.*

This soil contains adequate supplies of mineral plant food constituents, particularly calcium carbonate. The percentage of nitrogen present is somewhat low and the land would probably benefit by a course of "green manuring." The nature of the soluble salts present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 5.—"Taken from cultivated land about 200 yards from the Juba River, behind the engineer's quarters. This land was for two years under irrigation, and a fairly thick deposit of river silt had settled on the surface." A sample of fine-textured loam. The soil contained 4·02 per cent. of calcium carbonate ($CaCO_3$) in the form of broken shells and small nodules.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	5·61	44·81	35·16	10·17	0·23 [1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (Cl), *sulphates equivalent to* 0·03 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·06 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	4·41	—	—
Magnesia MgO	—	2·59	—	—
Potash K_2O	—	1·16	0·02	524
Ferric oxide Fe_2O_3	—	7·88	—	—
Phosphoric acid P_2O_5	—	0·16	0·05	1,311
Nitrogen N	0·07[1]	—	—	—
Carbon dioxide CO_2	1·77	—	—	—
Loss on ignition	20·72	—	—	—
Humus	0·63[2]	—	—	—

[1] *Equivalent to* 1,835 *lb. per acre.* [2] *Containing nitrogen* 3·43 *per cent.*

This soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen present is low, and the land would probably benefit by a course of "green manuring." The soil contains too large a percentage of sodium carbonate to be used for the cultivation of crops sensitive to alkali.

No. 6.—"River silt." A sample of loamy clay soil. It contained 9·88 per cent. of calcium carbonate ($CaCO_3$) in the form of broken shells and small nodules.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	10·32	12·60	57·69	9·31	0·20[1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·05 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·03 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	5·22	—	—
Magnesia MgO	—	2·43	—	—
Potash K_2O	—	0·94	0·02	520
Ferric oxide Fe_2O_3	—	7·36	—	—
Phosphoric acid P_2O_5	—	0·16	0·05	1,300
Nitrogen N	0·06[1]	—	—	—
Carbon dioxide CO_2	4·35	—	—	—
Loss on ignition	20·95	—	—	—
Humus	0·72[2]	—	—	—

[1] *Equivalent to* 1,559 *lb. per acre.* [2] *Containing nitrogen* 2·56 *per cent.*

This soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen present is low and the land would probably benefit by "green manuring." The nature of the soluble salts present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 7.—"Taken from cultivated land about 100 yards north-east of the Swedish Mission, Yonti, on a part of the land proposed to be used as a Government Experimental Farm." A sample of highly calcareous clay soil. It contained 16·09 per cent. of calcium carbonate ($CaCO_3$) in the form of broken shells and small nodules.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	4·42	19·26	50·14	9·16	0·93 [1]

[1] *Including chlorides equivalent to* 0·20 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·28 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·015 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	10·52	—	—
Magnesia MgO	—	2·01	—	—
Potash K_2O	—	1·40	0·10	2,367
Ferric oxide Fe_2O_3	—	6·52	—	—
Phosphoric acid P_2O_5	—	0·33	0·17	4,025
Nitrogen N	0·19 [1]	—	—	—
Carbon dioxide CO_2	7·08	—	—	—
Loss on ignition	22·96	—	—	—
Humus	1·46 [2]	—	—	—

[1] *Equivalent to* 4,499 *lb. per acre.* [2] *Containing nitrogen* 4·04 *per cent.*

This soil contains a sufficiency of plant food constituents, being particularly well supplied with calcium carbonate, "available" potash, and phosphoric acid. The nature of the soluble matter present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 8.—"Collected on low-lying land, sometimes flooded by fresh water, on plot No. 2, about 100 yards from the Juba River. The plants growing here include a Commelina and various members of Malvaceæ and Compositæ." A sample of fine-textured and calcareous loam. The soil contained 13·22 per cent. of calcium carbonate ($CaCO_3$) in the form of broken shells and small nodules.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent. Nil	*Per cent.* 8·59	*Per cent.* 40·65	*Per cent.* 30·79	*Per cent.* 6·55	*Per cent.* 0·20 [1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·03 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·055 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	8·45	—	—
Magnesia MgO	—	2·07	—	—
Potash K_2O	—	1·19	0·08	1,970
Ferric oxide Fe_2O_3	—	5·60	—	—
Phosphoric acid P_2O_5	—	0·23	0·10	2,463
Nitrogen N	0·17 [1]	—	—	—
Carbon dioxide CO_2	5·82	—	—	—
Loss on ignition	19·00	—	—	—
Humus	1·68 [2]	—	—	—

[1] *Equivalent to* 4,188 *lb. per acre.* [2] *Containing nitrogen* 3·59 *per cent.*

This soil contains a sufficiency of plant food constituents, being particularly well supplied with calcium carbonate, "available" potash, and phosphoric acid. The soil contains too large a percentage of sodium carbonate to be useful for the successful cultivation of plants sensitive to alkali.

No. 9.—"Collected about half a dozen yards from bank of Juba River, in centre of patch of an *Astragalus* sp., or vetch-like plant, on site of proposed Experimental Farm,

Yonti." A sample of light brown and calcareous sandy soil. It contained 8·25 per cent. of calcium carbonate ($CaCO_3$) in the form of broken shells and small nodules.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	53·71	26·25	9·58	2·08	0·13 [1]

[1] *Including a trace of chlorides, sulphates equivalent to* 0·02 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·015 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	4·69	—	—
Magnesia MgO	—	0·65	—	—
Potash K_2O	—	0·37	0·02	561
Ferric oxide Fe_2O_3	—	2·68	—	—
Phosphoric acid P_2O_5	—	0·13	0·02	561
Nitrogen N	0·05 [1]	—	—	—
Carbon dioxide CO_2	3·33	—	—	—
Loss on ignition	7·38	—	—	—
Humus	0·36 [2]	—	—	—

[1] *Equivalent to* 1,403 *lb. per acre.* [2] *Containing nitrogen* 6·77 *per cent.*

This soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen is low, and the soil would probably benefit by "green manuring." The nature of the soluble matter present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 10.—"Collected about 150 yards from Juba River and about 100 yards south of native place of worship on proposed Experimental Farm, Yonti. Small trees of 'John Bull,' *Thespesia* sp., are growing on the land; also grass from 1½ to 2 ft. high, much liked by cattle." A sample of dark brown calcareous loam. The soil contained 11·05 per cent. of calcium carbonate ($CaCO_3$), in the form of broken shells and small nodules.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	22·99	28·71	30·27	6·77	0·21[1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (Cl), *sulphates equivalent to* 0·02 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·019 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	7·49	—	—
Magnesia MgO	—	1·52	—	—
Potash K_2O	—	0·89	0·06	1,432
Ferric oxide Fe_2O_3	—	4·60	—	—
Phosphoric acid P_2O_5	—	0·28	0·10	2,386
Nitrogen N	0·14[1]	—	—	—
Carbon dioxide CO_2	4·86	—	—	—
Loss on ignition	16·51	—	—	—
Humus	1·24[2]	—	—	—

[1] *Equivalent to* 3,340 *lb. per acre.* [2] *Containing nitrogen* 3·36 *per cent.*

This soil contains a sufficiency of plant food constituents, being particularly well supplied with calcium carbonate, "available" potash, and phosphoric acid. The nature of the soluble salts present may render this soil unsuitable for the cultivation of crops sensitive to alkali.

No. 11.—"Collected from about the centre of a small plain about 100 yards west of native cemetery adjoining the site of the suggested Experimental Farm. The only vegetation is a creeping grass resembling Cynodon. During heavy rains this land is under water. The area of the small plain referred to above is about 650 yards by 300 yards, and would be included in the Experimental Farm section." A sample of calcareous, clayey soil which contained 9·82 per cent. of calcium carbonate ($CaCO_3$) in the form of lumps and fine particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	1·00	26·00	52·92	10·16	0·10 [1]

[1] *Including chlorides equivalent to* 0·03 *per cent. of chlorine* (Cl), *sulphates equivalent to* 0·01 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·02 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	5·77	—	—
Magnesia	MgO	—	1·87	—	—
Potash	K_2O	—	0·77	0·03	762
Ferric oxide	Fe_2O_3	—	7·84	—	—
Phosphoric acid	P_2O_5	—	0·15	0·02	508
Nitrogen	N	0·06 [1]	—	—	—
Carbon dioxide	CO_2	4·32	—	—	—
Loss on ignition		21·29	—	—	—
Humus		0·62 [2]	—	—	—

[1] *Equivalent to* 1,600 *lb. per acre.* [2] *Containing nitrogen* 5·8 *per cent.*

The soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen is low and the soil would probably benefit by "green manuring." The nature of the soluble salts present renders the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 12.—"Collected on the small plain about 150 yards from the Swedish Mission on Experimental Farm area, Yonti." A sample of fine-textured and calcareous clay loam. It contained 11·16 per cent. of calcium carbonate ($CaCO_3$) in the form of lumps and fine particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	2·80	33·55	44·57	7·86	0·06 [1]

[1] *Including chlorides equivalent to* 0·003 *per cent. of chlorine* (Cl), *sulphates equivalent to* 0·015 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·014 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	8·09	—	—
Magnesia MgO	—	1·56	—	—
Potash K_2O	—	0·81	0·01	246
Ferric oxide Fe_2O_3	—	6·24	—	—
Phosphoric acid P_2O_5	—	0·14	0·02	492
Nitrogen N	0·09 [1]	—	—	—
Carbon dioxide CO_2	4·91	—	—	—
Loss on ignition	19·94	—	—	—
Humus	0·70 [2]	—	—	—

[1] *Equivalent to* 2,164 *lb. per acre.*

[2] *Containing nitrogen* 4·7 *per cent.*

This soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen is slightly low. The nature of the soluble salts present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 13.—"Collected from farm No. 1 from gently sloping land just out of flood area, about 120 yards east of dwelling-house and 100 yards from Juba River. The vegetation is small Acacia scrub and dwarf grass." A sample of sandy loam, which contained 3·41 per cent. of calcium carbonate ($CaCO_3$) in the form of fine particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0·48	45·20	15·55	29·82	5·50	0·04 [1]

[1] *Including a trace of chlorides, sulphates equivalent to* 0·018 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equal to* 0·003 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO . .	—	1·90	—	—
Magnesia MgO . .	—	0·19	—	—
Potash K_2O . .	—	0·48	0·01	264
Ferric oxide Fe_2O_3 . .	—	3·52	—	—
Phosphoric acid P_2O_5 . .	—	0·02	0·007	185
Nitrogen N . . .	0·053[1]	—	—	—
Carbon dioxide CO_2 . .	1·50	—	—	—
Loss on ignition . . .	9·77	—	—	—
Humus	0·32[2]	—	—	—

[1] *Equivalent to* 1,400 *lb. per acre.* [2] *Containing nitrogen* 5·6 *per cent.*

The soil contains a sufficiency of mineral plant food constituents, except that the reserve of phosphoric acid, as shown by the quantity soluble in hydrochloric acid, is low. The percentage of nitrogen is also low and "green manuring" would probably prove beneficial. The quantity of alkali salts present is not likely to prove injurious to plant growth, except perhaps in the case of those very sensitive to alkali.

No. 14.—"Farm No. 1. Taken from west side of a millet shamba about 100 yards north of spot from which sample No. 1 was collected." A sample of clay soil. It contained 7·23 per cent. of calcium carbonate ($CaCO_3$) in the form of fine particles and shells.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0·01	3·75	11·90	66·98	10·06	0·07[1]

[1] *Including chlorides equivalent to* 0·004 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·022 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·016 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	4·38	—	—
Magnesia	MgO	—	1·42	—	—
Potash	K_2O	—	0·72	0·019	448
Ferric oxide	Fe_2O_3	—	7·36	—	—
Phosphoric acid	P_2O_5	—	0·14	0·035	825
Nitrogen	N	0·08[1]	—	—	—
Carbon dioxide	CO_2	3·18	—	—	—
Loss on ignition		19·61	—	—	—
Humus		0·52[2]	—	—	—

[1] *Equivalent to* 2,004 *lb. per acre.* [2] *Containing nitrogen* 5·8 *per cent.*

The soil contains a sufficiency of mineral plant food constituents, but the amount of nitrogen present is low, and the soil would probably benefit by "green manuring." The nature of the soluble salts present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 15.—"Farm No. 1. Collected from about the centre of flood area, on plain about one-third the distance between the dwelling-houses of farm No. 1 and Bulmerara. Vegetation—small Acacia shrubs and low grass of a sparse nature." A sample of calcareous clayey soil. It contained 8·16 per cent. of calcium carbonate ($CaCO_3$), in the form of pieces of shell and finely divided particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	1·33	12·20	67·16	10·94	0·21[1]

[1] *Including chlorides equivalent to* 0·02 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·02 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·042 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	6·45	—	—
Magnesia MgO	—	2·32	—	—
Potash K_2O	—	1·29	0·01	247
Ferric oxide Fe_2O_3	—	8·20	—	—
Phosphoric acid P_2O_5	—	0·14	0·03	743
Nitrogen N	0·09 [1]	—	—	—
Carbon dioxide CO_2	3·60	—	—	—
Loss on ignition	23·49	—	—	—
Humus	0·73 [2]	—	—	—

[1] *Equivalent to* 2,229 *lb. per acre.* [2] *Containing nitrogen* 4·60 *per cent.*

This soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen is slightly low. The amount of alkali present is probably too large to permit of the successful cultivation of certain crops sensitive to alkali.

No. 16.—"Collected from about the centre of plain, and midway between the dwelling-houses of farm No. 1 and Bulmerara. During flood time the area is under water. Commelina, sparse low grass, and tiny shrubs compose the vegetation." A sample of fine-textured and calcareous clay loam. The soil contained 9·32 per cent. of calcium carbonate ($CaCO_3$), in the form of broken shells and small nodules under ¼ in. diameter.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	3·42	50·36	26·23	10·55	0·12 [1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·02 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·018 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	6·63	—	—
Magnesia MgO	—	2·13	—	—
Potash K_2O	—	1·03	0·02	482
Ferric oxide Fe_2O_3	—	8·32	—	—
Phosphoric acid P_2O_5	—	0·21	0·06	1,447
Nitrogen N	0·07 [1]	—	—	—
Carbon dioxide CO_2	4·10	—	—	—
Loss on ignition	23·23	—	—	—
Humus	0·58 [2]	—	—	—

[1] *Equivalent to* 1,688 *lb. per acre.* [2] *Containing nitrogen* 3·73 *per cent.*

This soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen present is low, and the soil would probably benefit by "green manuring." The nature of the soluble salts present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 17.—"Taken two yards from boundary of farm No. 1 and Bulmerara (on farm No. 1 side) and adjoining [land] recently cultivated and ridged on the Bulmerara Estate. The position is on a straight line between the dwelling-houses of the farm named above." A sample of calcareous clayey soil. It contained 12·66 per cent. of calcium carbonate ($CaCO_3$) in the form of lumps, fine particles, and shells.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	2·75	5·50	67·46	11·56	0·07 [1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·026 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·007 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	8·03	—	—
Magnesia MgO	—	1·35	—	—
Potash K_2O	—	0·99	0·014	353
Ferric oxide Fe_2O_3	—	7·92	—	—
Phosphoric acid P_2O_5	—	0·25	0·049	1,235
Nitrogen N	0·071 [1]	—	—	—
Carbon dioxide CO_2	5·57	—	—	—
Loss on ignition	23·48	—	—	—
Humus	0·53 [2]	—	—	—

[1] *Equivalent to* 1,789 *lb. per acre.* [2] *Containing nitrogen* 4·7 *per cent.*

The soil contains a sufficiency of mineral plant food constituents, but the amount of nitrogen is low, and the soil would probably benefit by "green manuring." The soluble salts present are not likely to prove harmful to plant growth, except perhaps in the case of plants very sensitive to alkali.

No. 18.—"Collected on Bulmerara Estate in the centre of a small field, which at the time of collection was lying fallow, but in 1911 gave a return of 1,400 lb. of seed-cotton per acre. Formerly the land had a dense growth of Doum palms." A sample of highly calcareous clayey soil. It contained 14·36 per cent. of calcium carbonate ($CaCO_3$) in the form of lumps and fine particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	1·50	16·35	58·25	9·41	0·13 [1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·056 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·008 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	8·46	—	—
Magnesia	MgO	—	2·36	—	—
Potash	K_2O	—	1·07	0·032	858
Ferric oxide	Fe_2O_3	—	6·96	—	—
Phosphoric acid	P_2O_5	—	0·29	0·109	2,924
Nitrogen	N	0·127 [1]	—	—	—
Carbon dioxide	CO_2	6·32	—	—	—
Loss on ignition		21·78	—	—	—
Humus		0·95 [2]	—	—	—

[1] *Equivalent to* 3,406 *lb. per acre.* [2] *Containing nitrogen* 4·8 *per cent.*

This soil contains a good supply of plant food constituents, particularly "available" phosphoric acid and calcium carbonate. The quantity of soluble salts present is not likely to prove injurious to plant growth, except perhaps in the case of plants very sensitive to alkali.

No. 19.—"Collected on Mr. Powys Cobb's farm at a spot about 150 yards from the Juba River in a straight line with the dwelling-house. The land is under water during flood-time. Vegetation—good grass." A sample of calcareous clayey soil, which contained 13·41 per cent. of calcium carbonate ($CaCO_3$) in the form of lumps and fine particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture. at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	0·55	13·55	61·04	11·35	0·10 [1]

[1] *Including chlorides equivalent to* 0·005 *per cent. of chlorine* (Cl), *sulphates equivalent to* 0·002 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·055 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	9·15	—	—
Magnesia MgO	—	1·72	—	—
Potash K_2O	—	0·92	0·017	435
Ferric oxide Fe_2O_3	—	5·86	—	—
Phosphoric acid P_2O_5	—	0·19	0·035	896
Nitrogen N	0·093 [1]	—	—	—
Carbon dioxide CO_2	5·90	—	—	—
Loss on ignition	23·09	—	—	—
Humus	0·82 [2]	—	—	—

[1] *Equivalent to* 2,381 *lb. per acre.* [2] *Containing nitrogen* 3·5 *per cent.*

The soil contains a sufficiency of mineral plant food constituents, but the amount of sodium carbonate present will prohibit its use for the cultivation of certain crops sensitive to alkali.

No. 20.—"Collected on Mr. Powys Cobb's farm about 450 yards from Juba River in a line with the dwelling-house. The land is under water during high flood. Vegetation—rank grass of a tiny bamboo-like nature." A sample of calcareous clay soil. It contained 16·50 per cent. of calcium carbonate ($CaCO_3$) in the form of lumps, fine particles, and shells.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0·12	1·45	11·20	59·03	11·66	0·04 [1]

[1] *Including chlorides equivalent to* 0·005 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·001 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·007 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	9·72	—	—
Magnesia	MgO	—	1·44	—	—
Potash	K_2O	—	0·94	0·025	559
Ferric oxide	Fe_2O_3	—	8·08	—	—
Phosphoric acid	P_2O_5	—	0·41	0·050	1,118
Nitrogen	N	0·143 [1]	—	—	—
Carbon dioxide	CO_2	7·26	—	—	—
Loss on ignition		25·27	—	—	—
Humus		1·40 [2]	—	—	—

[1] *Equivalent to* 3,196 *lb. per acre.* [2] *Containing nitrogen* 2·6 *per cent.*

The soil contains a sufficiency of plant food constituents. The amount of soluble salts present is not likely to prove harmful to plant growth, except perhaps in the case of plants which are very sensitive to alkali.

No. 21.—"Taken from a spot just outside flood area, about 750 yards from the Juba River in a straight line with the dwelling-house. Grass short and good. The Doum palms commence about 450 yards behind this spot or 1,150 yards from the Juba River." A calcareous, clayey soil, which contained 12·34 per cent. of calcium carbonate ($CaCO_3$) in the form of small nodules and finely divided particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	1·59	7·07	70·06	8·81	0·13 [1]

[1] *Including a trace of chlorides, sulphates equivalent to* 0·02 *per cent. oj sulphuric acid* (*SO_3*), *and alkaline carbonates equivalent to* 0·026 *per cent. o sodium carbonate* (*Na_2CO_3*).

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	9·84	—	—
Magnesia MgO	—	2·68	—	—
Potash K_2O	—	0·47	0·04	953
Ferric oxide Fe_2O_3	—	7·52	—	—
Phosphoric acid P_2O_5	—	0·36	0·09	2,145
Nitrogen N	0·10 [1]	—	—	—
Carbon dioxide CO_2	5·43	—	—	—
Loss on ignition	23·33	—	—	—
Humus	1·22 [2]	—	—	—

[1] *Equivalent to* 2,383 *lb. per acre.* [2] *Containing nitrogen* 3·94 *per cent.*

This soil contains a sufficiency of plant food constituents. The nature of the soluble salts present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 22.—"Collected on fallow land on Count Francken-stein's farm (No. 7) about 200 yards from the Juba River in a straight line with the dwelling-house." A sample of calcareous, clayey soil. It contained 18·91 per cent. of calcium carbonate ($CaCO_3$), in the form of fine particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	0·45	20·10	52·77	7·70	0·07 [1]

[1] *Including chlorides equivalent to* 0·004 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·018 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·014 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	11·70	—	—
Magnesia MgO	—	1·79	—	—
Potash K_2O	—	0·79	0·049	1,264
Ferric oxide Fe_2O_3	—	8·16	—	—
Phosphoric acid P_2O_5	—	0·17	0·063	1,626
Nitrogen N	0·12 [1]	—	—	—
Carbon dioxide CO_2	8·32	—	—	—
Loss on ignition	22·33	—	—	—
Humus	1·36 [2]	—	—	—

[1] *Equivalent to* 3,097 *lb. per acre.* [2] *Containing nitrogen* 3·1 *per cent.*

The soil contains a sufficiency of plant food constituents. The nature and quantity of the alkali salts present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 23.—"Collected at a spot about 200 yards north-east of dwelling-house on farm No. 7 and close to the boundary of farm No. 6—also the property of Count Franckenstein. Low, good grass." A sample of calcareous, clayey soil. It contained 14·23 per cent. of calcium carbonate ($CaCO_3$) in the form of fine particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	1·15	5·70	66·79	12·08	0·05[1]

[1] *Including a trace of chlorides, sulphates equivalent to* 0·015 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·008 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	9·32	—	—
Magnesia MgO	—	1·94	—	—
Potash K_2O	—	0·62	0·015	378
Ferric oxide Fe_2O_3	—	8·48	—	—
Phosphoric acid P_2O_5	—	0·16	0·025	630
Nitrogen N	0·103[1]	—	—	—
Carbon dioxide CO_2	6·26	—	—	—
Loss on ignition	25·93	—	—	—
Humus	1·41[2]	—	—	—

[1] *Equivalent to* 2,595 *lb. per acre.* [2] *Containing nitrogen* 3·5 *per cent.*

The soil contains a sufficiency of plant food constituents. The quantity of soluble salts present is not likely to prove harmful to plant growth, except perhaps in the case of those plants which are very sensitive to alkali.

No. 24.—"Taken about 500 yards away from Juba River on farm No. 7, in a straight line with dwelling-house. The land is under water during high flood and contains rank,

reed-like grass." A calcareous clay soil which contained 10·25 per cent. of calcium carbonate ($CaCO_3$), in the form of lumps and fine particles.

Mechanical Analysis

Sizes of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	0·25	0·55	74·26	14·64	0·05 [1]

[1] *Including chlorides equivalent to* 0·007 *per cent. of chlorine* (Cl), *sulphates equivalent to* 0·017 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·008 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	7·42	—	—
Magnesia	MgO	—	1·66	—	—
Potash	K_2O	—	0·94	0·028	671
Ferric oxide	Fe_2O_3	—	8·40	—	—
Phosphoric acid	P_2O_5	—	0·21	0·083	1,990
Nitrogen	N	0·146 [1]	—	—	—
Carbon dioxide	CO_2	4·51	—	—	—
Loss on ignition		27·08	—	—	—
Humus		1·55 [2]	—	—	—

[1] *Equivalent to* 3,501 *lb. per acre.* [2] *Containing nitrogen* 3·8 *per cent.*

This soil contains a sufficiency of plant food constituents. The quantity of soluble salts present is not likely to prove harmful to plant growth, except perhaps in the case of those plants which are very sensitive to alkali.

Remarks

Nearly all the soils under report are of a clayey character and have good moisture-retaining properties. They all contain adequate quantities of calcium carbonate; in many instances, *e.g.* samples Nos. 4, 6, 7 to 12, and 14 to 24, the quantity present substantially exceeds 6 per cent. This constituent is of considerable importance in improving the heavy nature of the clay.

The quantity of the mineral constituents necessary for plant growth is adequate in all cases, but the amount of total phosphoric acid is below standard in soil No. 13.

Certain of the soils are somewhat deficient in nitrogen, and the percentage of this constituent in the humus is in some cases rather low. Both these defects might be remedied by "green manuring."

All the soils were found to contain alkaline carbonates, which have a very harmful effect on plant growth when present in quantity. Sodium chloride and sulphates were also present, but not in quantities likely to prove injurious, except perhaps in the case of soil No. 7. In this respect the soils differ from a sample previously examined from Halwalood (this BULLETIN, 1912, **10**, 418), which contained 1·31 per cent. of sodium sulphate and 0·28 per cent. of sodium chloride.

In the descriptions which accompanied the samples, it is stated that the land represented by samples Nos. 8, 11, 15, 16, 19, 20, and 24, is subject to periodical flooding. This being the case, it would be necessary to exercise care in the reclaiming of such land, as the prevention of this flooding may lead to the accumulation of considerable quantities of alkali salts in the surface soil. If the land is irrigated, without under-drainage being adopted, the isolated patches containing high proportions of alkali may spread to the areas not yet seriously affected, but the danger in the case of clay soils is somewhat less than in the case of those of a sandy character.

As the quantity of sodium chloride present in all the soils is low, except in the case of soil No. 7, it seems possible that the harmful effect of the sodium carbonate can be minimised by applying dressings of calcium sulphate ("land plaster"). According to Loughbridge (*Annual Report of Californian Experiment Station*, 1896–7) the quantity of calcium sulphate applied to a soil for this purpose should be about double the weight of sodium carbonate present in the soil to a depth of 4 ft. An excess of calcium sulphate will do no harm unless the soil is badly waterlogged.

The *minimum* quantity of calcium sulphate required, on Loughbridge's estimate, to neutralise the sodium carbonate

in soils containing varying amounts of the alkali, is shown in the following table. The calculations are based on the requirements of the soil to a depth of 4 ft., and on the assumption that the soil has an apparent specific gravity of 1·3.

Sodium carbonate in soil. *Per cent.*	Calcium sulphate required. *lb. per acre.*
0·001	288
0·005	1,442
0·01	2,884
0·10	28,840

With reference to the possibility of obtaining crops on land containing alkali, without previous treatment, there seems to be little information available. The figures in the following table, compiled from the data given in *Bulletins* 128, 133, and 140 of the *Californian Experiment Station*, may be of service in this connection. They give the maximum tolerance of various crops towards sodium carbonate.

	Sodium carbonate in 4 ft. of soil. *lb. per acre.*	*Per cent.*[1]
Wheat . . .	1,480	0·013
Barley . . .	12,170	0·112
Rye . . .	960	0·009
Sweet corn . .	1,800	0·016
Kaffir corn . .	1,800	0·016
Sunflower . .	1,760	0·016
Alfalfa . . .	2,360	0·022
Sorghum . .	9,840	0·091
Hairy vetch . .	2,480	0·023
Apples . . .	640	0·006
Pears . . .	1,760	0·016
Lemons . .	480	0·004

[1] *Calculated for a soil having an apparent specific gravity of* 1·3.

In many of the above cases the sodium carbonate was accompanied by small quantities of calcium sulphate, which would have an ameliorating effect.

In considering these figures in relation to the soils under report, it must be remembered that owing to the close proximity of the Juba River to many of the areas from which the samples were taken, it is highly probable that during the year there will be wide variations in the quantity of soluble salts in the surface soil, owing to variations in the level of the water table.

The results of analyses given in the present report are useful as indicating the kind of crop which could probably be grown on the soils. Other factors, however, such as climate, must also be taken into consideration, and before any definite conclusions in this direction can be reached it would be necessary to carry out trial cultivation experiments This is especially the case with soils such as those dealt with above, which contain small amounts of alkali salts.

TEA FROM NEW SOURCES

The cultivation of tea has been attempted in a number of British possessions outside India and Ceylon, and notably in parts of Africa. The industry in Natal and Nyasaland has already been referred to in this Bulletin (1908, **6**, 1; 1913, **11**, 302). Experiments in tea growing have been made by the Department of Agriculture in the Southern Provinces, Nigeria, and two samples of the product have been examined at the Imperial Institute; they proved to be of good quality (this Bulletin, 1912, **10**, 395). Samples of tea have also been received from Uganda, East Africa Protectorate, and Fiji, and these are dealt with in the following pages.

Uganda

Tea growing in Uganda is at present only in the experimental stage, two plots being grown at the Government Plantation at Kampala. In the lower plot, situated near a drained swamp, the growth has been good, but in the other, at a higher level, the plants are stunted and make little or no progress.

A sample of tea grown and prepared at Kampala was received at the Imperial Institute in November 1913. It consisted of rolled black tea, dry and in good condition, but of somewhat uneven colour, a small quantity of light-coloured leaf being present.

The tea was chemically examined with the following results:

	Expressed on material as received. Per cent.	Expressed on material dried at 100° C. Per cent.
Moisture	8·05	—
Caffeine	3·67	4·0
Tannin [1]	9·5	10·3
Ash	4·76	5·2
Extract [2]	36·0	39·1

[1] *Determined by Procter's modification of Lowenthal's process.*

[2] *The percentage dissolved by treating a given quantity of tea with one hundred times its weight of boiling water and allowing it to infuse for* 10 *minutes.*

The following are the corresponding results obtained at the Imperial Institute for Indian and China teas:

	Material as received.	Material dried at 100° C.			
	Moisture.	Caffeine.	Tannin.	Ash.	Extract.
Indian teas (13 samples):	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Maximum	7·8	4·1	11·1	6·9	35·2
Minimum	6·4	3·6	6·9	5·4	27·4
Average	7·1	3·8	9·2	6·0	31·7
China teas (8 samples):					
Maximum	9·2	3·7	9·3	8·2	27·2
Minimum	7·1	2·6	3·3	6·0	19·0
Average	8·2	3·0	5·2	6·8	24·3

From a comparison with these figures it will be seen that the present sample of Uganda tea is rich in caffeine, tannin, and extractive matter, and that in this respect it resembles Indian rather than China tea.

The sample was submitted to a firm of brokers, who reported that it represented a blackish, rather bold and mixed, unassorted tea, with some white tip. The liquor was of fair strength, with some quality, but was very light in colour; and the infused tea, whilst generally of good colour, was uneven, with some greenish leaves. The brokers stated that the value of the tea was uncertain, but might be nominally about 8½*d.* to 9*d.* per lb. in London (January 1914).

The brokers mentioned that this tea was very similar in style and appearance to a variety which used to be received from Java some years ago, called "Flowery Pekoe," but they added that the present sample had evidently not been graded. Compared with that of Indian, Ceylon, and Java teas, the liquor was in their opinion too thin to attract the

competition of most buyers in London. They considered that the tea might with advantage be given a longer fermentation and also a heavier rolling, which would tend to increase the colour and strength of the liquor.

The firm added that the sample showed very fair manufacture, and if the suggestions made above were acted upon, they were of opinion that quite a satisfactory price would be realised in London, provided the tea came forward in marketable quantities of say not less than 20 chests at a time, each weighing 90 to 100 lb. net, or twice the number of half-chests averaging about 50 lb. net.

Two further samples of tea which had been fermented for a longer period than the previous sample were received from Kampala in January 1914.

They were as follows:

No. 1, "*Golden Tip.*"—Dried, rolled tea, clean and in good condition, and varying from pale brown to black in colour, a large proportion of the paler leaf being present.

No. 2, "*Broken Leaf.*"—Dried, rolled, black tea, mostly composed of broken leaf, and containing a small proportion of powder.

The teas, as received, were examined with the following results, compared with the previous sample from Uganda:

	No. 1. Golden Tip.	No. 2. Broken Leaf.	Previous sample.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	8·8	8·8	8·05
Caffeine	4·90	3·85	3·67
Tannin	12·6	15·5	9·5
Ash	4·2	4·8	4·76
Extract	35·2	35·0	36·0

From the foregoing results it is seen that sample No. 1 contained a high percentage of caffeine, the average amount for Indian or Ceylon teas being about 3·5 to 4·0 per cent. In other respects the tea is of normal composition, though the percentage of tannin is rather higher than usual.

The analysis of sample No. 2 shows it to be of normal composition, and to resemble closely the previous sample of Uganda tea examined at the Imperial Institute, except as regards the percentage of tannin. The amount of this constituent appears to have been considerably increased by

the longer fermentation to which the leaf had been subjected as compared with the previous sample.

The samples were submitted to a firm of brokers, who valued No. 1 at about 1*s.* 4*d.* and No. 2 at about 8*d.* per lb. in London (August 1914). They added that the "Golden Tip" leaf, No. 1, was a somewhat fancy article, which they considered could only be produced in small quantities.

The firm stated that the longer fermentation to which these teas had been subjected, as compared with the earlier sample from Uganda, had resulted in some improvement in the colour of the liquor, but there is still a lack of strength in comparison with Indian and Ceylon teas. They suggested that this defect might be remedied by harder rolling.

East Africa Protectorate

Tea was first grown in the East Africa Protectorate on an estate at Limoru in 1904, from seed imported from India. The plants grew well, and localities similar to Limoru, where the rainfall is 60 in. or over in a normal year, and the air cool, seem well adapted for tea planting.

A sample of tea grown on this estate, and prepared by hand, was examined at the Imperial Institute in 1909.

It was black tea of good aroma, and was analysed with the following results, compared with the average figures for a number of Indian and China teas examined at the Imperial Institute (see p. 541):

	Present sample. *Per cent.*	Average of Indian teas. *Per cent.*	Average of China teas. *Per cent.*
Moisture	8·6	7·1	8·2
Caffeine	5·0	3·8	3·0
Tannin	9·6	9·2	5·2
Ash	4·8	6·0	6·8
Extract	33·9	31·7	24·3

All the above percentages, except the "moisture," are calculated on the material dried at 100° C.

The results show that this tea from the East Africa Protectorate resembles Indian tea in the amount of extractive matter and tannin present, but that it contains an unusually high percentage of caffeine.

The tea was submitted to a firm of brokers, who

reported that it had on the whole been carefully prepared, that the twist of the leaf was good, but that the leaves were irregular in size, being unsorted. The liquor obtained on infusion was found to be of very fair quality, and the tea generally resembled that from several Ceylon gardens.

The tea was valued at from 6½*d.* to 7*d.* per lb. (March 1909).

The investigation shows that tea of good saleable character can be grown in the Limoru district of the East Africa Protectorate with prospects of success.

Fiji

A sample of tea, described as Orange Pekoe from the Wainunu Estate, Fiji, was received for examination in July 1909. It was a black tea containing some tip and was of fairly satisfactory appearance. The leaf was of a useful size but somewhat broken.

A chemical examination of the tea gave the following results, which are compared in the table with corresponding figures for Indian and China teas previously investigated at the Imperial Institute (see p. 541).

	Present sample.		Average of Indian teas. Material dried at 100° C.	Average of China teas. Material dried at 100° C.
	Material as received.	Material dried at 100° C.		
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . .	10·6	—	—	—
Caffeine . .	2·8	3·1	3·8	3·0
Tannin . .	7·9	8·9	9·2	5·2
Ash . . .	4·6	5·2	6·0	6·8
Extract . .	26·2	29·3	31·7	24·3

It will be seen from these figures that the tea from Fiji resembles the Indian teas in the percentage of tannin present, but that it contains a smaller amount of caffeine, agreeing in the latter respect with the China teas. The percentage of "extract" is between those given by the Indian and China teas.

The firing of this tea appeared to have been carried out at rather too high a temperature, with the result that the sample smelt rather scorched. The infusion had but little strength, was light in colour, and tasted slightly

burnt or "over-fired." The infused leaf was too dark and mixed.

The tea was submitted to commercial experts, who valued it at $7\frac{1}{2}d.$ per lb. (December 1909). They stated, however, that this valuation was based almost entirely on the appearance of the tea. For the reasons already mentioned, the "liquor" was regarded as unsatisfactory, and in this respect the tea could only be classed with inferior descriptions. A better product would no doubt be obtained with more careful preparation.

NUTS OF *CANARIUM* Spp.

DURING the last few years the nuts of species of *Canarium*, known as "pili" nuts, have come into prominence in the United States for dessert use. They are obtained largely from wild trees in the Philippine Islands, the most important species, according to the Chief of the Division of Horticulture, Manila, being *C. luzonicum*, the source of Manila elemi. The total exports of pili nuts from Manila in 1913 amounted to about 900 tons. Another species, *C. commune*, is cultivated in the Moluccas for the sake of its nuts, the kernels of which are eaten there as well as in Java and the Straits Settlements.

With a view to determining the value of *Canarium* kernels as a substitute for sweet almonds in confectionery, supplies of the nuts of *C. commune* and *C. rufum* were obtained from the Straits Settlements as well as nuts of *C. Colophania* from Mauritius. The results of examination of the nuts are given below.

Canarium commune *Nuts from the Straits Settlements.*—The sample consisted of nuts measuring about $1\frac{3}{8}$ in. in length and $\frac{7}{8}$ in. in diameter, somewhat resembling Spanish chestnuts in shape, and pale brownish-grey to dark brown in colour. The shells were about $\frac{1}{8}$ in. in thickness, and very hard.

The nuts consisted of shell 87·1 per cent., and kernel 12·9 per cent. Most of them contained at least two kernels, about 30 per cent. contained three kernels, and a few contained only one. The kernels had a chocolate-coloured

coat, enclosing a cream-coloured interior which had a pleasant oily taste.

Canarium rufum *Nuts from the Straits Settlements.*—These nuts had a brown, tough outer coat of shrunken appearance, about $\frac{1}{8}$ in. thick, which in a few cases had partially rotted away. The outer coat enclosed a three-sided, hard nut, tapering to a point at each end, of a brown colour, and about $1\frac{3}{4}$ in. long and $\frac{3}{4}$ in. thick. Embedded in the woody shell were three slender kernels about 1 in. long, and from $\frac{1}{8}$ to $\frac{1}{4}$ in. thick, and having a brown seed-coat. The kernels were white and oily, and had a pleasant taste.

The nuts consisted of husk 95·3 per cent., and kernel 4·7 per cent. (seed-coat 1·6 per cent., interior 3·1 per cent.).

The higher percentage of husk in the present sample is, to a certain extent, due to the presence of the outer coat of the fruit, which had been removed in the case of the *C. commune* nuts.

Canarium Colophania *Nuts from Mauritius.*—These nuts consisted of a comparatively small kernel surrounded by a thick hard shell. The average dimensions of the whole nuts were $1\frac{1}{2}$ by $\frac{5}{8}$ in., and of the kernels $\frac{3}{4}$ by $\frac{3}{16}$ in. The nuts were composed of shell 96 per cent., and kernel 4 per cent. The kernels possessed a pleasant taste.

The kernels of these *Canarium* nuts were analysed with the following results; in the case of *C. commune* and *C. rufum*, the seed-coats were removed before analysis:

	C. commune.	*C. rufum.*	*C. Colophania.*
	Per cent.	*Per cent.*	*Per cent.*
Moisture	2·9	3·9	4·2
Crude proteins	13·5	16·4	15·9
Consisting of:			
True proteins	12·9	15·5	15·3
Other nitrogenous substances	0·6	0·9	0·6
Fat	72·3	70·5	64·6
Starch, etc.	7·4	4·2	9·0
Fibre	trace	trace	2·1
Ash	3·9	5·0	4·2
Nutrient ratio[1]	1 : 12·3	1 : 10·1	1 : 10
Food units[2]	221·9	221·4	210·5

[1] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.*

[2] *The total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins.*

The kernels of these nuts have a very high food value, and in the case of *C. commune* and *C. rufum* the proportion of fat is large, viz. 72·3 and 70·5 per cent., respectively, as compared with about 65 per cent. in the case of walnuts, filberts, and hazel nuts. Owing to the thickness of the shell and its extreme hardness the nuts are unlikely to be of any commercial value for export. The proportion of shell in the nuts was greatest in the case of those of *C. Colophania*, viz. 96 per cent., and at the same time they were more difficult to break.

If the nuts were shelled locally and the whole kernels alone exported, in good fresh condition, the product might perhaps find a market in European confectionery; but the kernels have no special advantage in taste over the kinds already used for this purpose, and as the nuts yield only a small proportion of kernels the extraction might be unremunerative at the price obtainable. A further obstacle to the commercial utilisation of the *C. Colophania* nuts is the fact that the tree is stated to produce fruits very irregularly in Mauritius.

BEANS FROM BRITISH WEST AFRICA

In a previous number of this Bulletin (1913, **11**, 230) an account was given of the results of examination at the Imperial Institute of a number of samples of beans from West Africa and elsewhere, and reference was made therein to earlier articles on the same subject. Since the former article was published, samples of beans from Sierra Leone, the Gold Coast, and Nigeria have been examined, and these are dealt with in the following pages.

Vigna Catjang Beans from Sierra Leone

A sample of "Kroo" beans, identified at the Royal Botanic Gardens, Kew, as *Vigna Catjang*, was received from Sierra Leone in April 1913.

They were small rounded beans about ¼ in. in diameter, plump on the whole, of fairly good appearance, and mostly pale pinkish-brown in colour with an admix-

ture of darker beans. The beans had a firm, cream coloured interior, and the taste was not unpleasant. The sample had suffered very slightly from insect attack, but was otherwise clean and free from extraneous matter.

The beans were analysed with the following results compared with a sample of *V. Catjang* beans from Hong Kong previously examined at the Imperial Institute (see this BULLETIN, 1912, **10**, 236), and with Indian Catjang beans as recorded by Church.

	Present sample.	Previous samples. From Hong Kong.	From India.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	11·3	11·7	12·7
Crude proteins	24·3	22·0	23·1
Consisting of:			
True proteins	22·3	20·4	—
Other nitrogenous substances	2·0	1·6	—
Fat	1·1	1·2	1·1
Starch, etc.	55·2	58·0	55·3
Fibre	4·9	3·8	4·2
Ash	3·2	3·2	3·6
Nutrient ratio [1]	1 : 2·4	1 : 2·7	1 : 2·5
Food units [2]	118·7	116·2	115·8

[1] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.*

[2] *The total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins.*

The beans contained no alkaloids or cyanogenetic glucosides.

The beans were submitted to a firm of merchants in London, who reported that they could only be used in the United Kingdom as a feeding-stuff for cattle, for which purpose they would be worth from £5 10*s.* to £5 15*s.* per ton c.i.f. (July 1913). The firm added that the beans would probably be difficult to sell at first, but that when better known they would probably realise higher prices.

PHASEOLUS LUNATUS BEANS FROM SIERRA LEONE

Two samples of "Towé" beans, identified at the Royal Botanic Gardens, Kew, as *Phaseolus lunatus*, were received from Sierra Leone in August 1913.

No. 1.—These beans, which measured approximately

1 by ⅝ in., were white, with black or very dark reddish-brown markings. The interior was of cream colour and possessed a not unpleasant taste. The sample was in good condition, clean, and free from insect attack.

No. 2.—Flat, kidney-shaped beans, measuring about 1 by ⅝ in., of a pinkish-brown colour with faint grey and black markings. The interior was of cream colour, and had a not unpleasant taste. The sample was in good condition, clean, and free from insect attack.

The beans were analysed with the following results:

	No. 1. *Per cent.*	No. 2. *Per cent.*
Moisture	11·3	13·4
Crude proteins	22·9	23·4
Consisting of:		
True proteins	21·4	21·0
Other nitrogenous substances	1·5	2·4
Fat	0·8	0·8
Starch, etc.	55·7	55·8
Fibre	4·8	3·8
Ash	2·7	2·8
Nutrient ratio	1 : 2·5	1 : 2·5
Food units	115	116

The beans contained no alkaloids, but on hydrolysis No. 1 yielded 0·025 per cent. and No. 2 0·03 per cent. of prussic acid.

In view of the fact that both these samples of towé beans yielded considerable quantities of prussic acid, they could not be recommended as suitable for local consumption in Sierra Leone or for export to the United Kingdom.

P. lunatus beans are well known to yield prussic acid. Full information on this subject will be found in previous articles in this BULLETIN (1903, **1**, 15, 112; 1905, **3**, 373; 1906, **4**, 334; 1912, **10**, 655).

SWORD BEANS (*CANAVALIA ENSIFORMIS*) FROM THE GOLD COAST

A sample of beans identified at the Royal Botanic Gardens, Kew, as *Canavalia ensiformis*, DC., was received from the Gold Coast in December 1913. The beans were stated to have been obtained from plants found growing on the sand along the sea-coast.

The sample consisted of irregularly shaped, more or less oval beans, measuring about $\frac{3}{8}$ in. in width and $\frac{5}{8}$ in. in length. The seed-coat was mottled, and varied in colour from pale to dark greenish-brown, whilst the husk was hard and brittle. Internally the beans were cream-coloured.

The beans were analysed with the following results, compared with a sample of sword beans (*C. ensiformis*) from British Honduras, examined at the Imperial Institute (see this BULLETIN, 1913, **11**, 242).

	Present sample. *Per cent.*	Sword beans from British Honduras. *Per cent.*
Moisture	8·2	14·4
Crude proteins	27·4	25·0
Consisting of:		
True proteins	17·5	—
Other nitrogenous substances	9·9	—
Fat	1·3	2·7
Starch, etc.	45·7	48·4
Fibre	14·7	6·8
Ash	2·7	2·7
Nutrient ratio	1 : 1·8	1 : 2·2
Food units	117·4	117

The beans contained no alkaloids or cyanogenetic glucosides.

These beans have a fairly high food value, and in particular are rich in proteins.

The samples of *C. ensiformis* beans examined at the Imperial Institute have not been found to contain any alkaloids or cyanogenetic glucosides, but it may be mentioned that the beans are stated to be looked upon with suspicion in Mauritius and elsewhere as being poisonous. This has apparently not been confirmed, but in view of the suspicion which appears to exist regarding the beans it would be necessary to carry out preliminary feeding trials before they could be recommended as a feeding-stuff.

Canavalia obtusifolia Beans from the Gold Coast

A sample of beans grown at Tamale, Northern Territories, Gold Coast, was received in July 1914. Specimens of the beans were submitted to the Director,

Royal Botanic Gardens, Kew, who stated that they were apparently *Canavalia obtusifolia*.

The beans, which were of a deep pink colour, were about 1⅓ in. long, ¾ in. wide, and ⅝ in. thick, and of an oval shape, tapering slightly at one end. The husk was tough and could be easily separated. The interior was cream-coloured, of a firm mealy consistency, and possessed a fairly agreeable taste. The average weight of the beans was 4·5 grams. The sample also included a pod about 6½ in. long, 1½ in. wide, and 1 in. thick. It was tough, somewhat wrinkled, and of a straw-yellow colour, and contained 5 beans.

The beans were analysed with the following results:

	Per cent.
Moisture	10·9
Crude proteins	22·0
Consisting of:	
True proteins	14·8
Other nitrogenous substances	7·2
Fat	1·9
Starch, etc.	54·5
Fibre	8·1
Ash	2·6
Nutrient ratio	1 : 2·6
Food units	114

The beans contained no alkaloids or cyanogenetic glucosides.

From the above analysis the beans are seen to have a fairly high food value, and to be generally similar in composition to the preceding sample of sword beans, though they contain less protein.

As a feeding-stuff for cattle, these beans are very promising, but, as in the case of the preceding sample of sword beans, it would be advisable to ascertain their suitability for this purpose by actual feeding trials.

Beans from Nigeria

A sample of beans collected at Lafia Nufawa, in Bassa Province, Nigeria, was received in March 1913.

The beans were kidney shaped, about ¾ in. long and ½ in. broad, clean and in good condition. They were white

in colour, but showed yellowish-brown stains, which were irregularly distributed, but occurred chiefly along the edge.

The beans were analysed with the following results, compared with Indian haricot beans as recorded by Church.

	Present sample. *Per cent.*	Indian haricot beans. *Per cent.*
Moisture	8·7	14·0
Crude proteins	22·5	23·0
Consisting of:		
True proteins	21·0	—
Other nitrogenous substances	1·5	—
Fat	0·7	2·3
Starch, etc.	61·6	52·3
Fibre	2·9	5·5
Ash	3·6	2·9
Nutrient ratio	1 : 2·8	1 : 2·5
Food units	120	116

The beans contained no alkaloids or cyanogenetic glucosides.

The beans were submitted to a firm of brokers, who reported that their value was very seriously reduced by the yellowish-brown stains referred to above, and that the present sample would be worth only about 6*s.* per cwt. If, however, the beans could be supplied without these stains they would be worth 12*s.* to 14*s.* per cwt. in London (September 1913).

BARLEY FROM CYPRUS

BARLEY is cultivated on a fairly extensive scale in Cyprus, the total production in 1913–14 amounting to 271,084 quarters. The exports in that year were 40,008 quarters, valued at £37,747. Of this amount 36,845 quarters, valued at £34,670, went to Egypt, and 2,125 quarters, valued at £2,122, to the United Kingdom.

A sample of barley grown in Cyprus was received at the Imperial Institute for examination in May 1914.

It was desired to ascertain the suitability of the barley for malting purposes, and the price which it would be likely to realise in the United Kingdom.

The sample consisted of moderately hard, pale-coloured barley. The grains were of medium size and fairly plump. The barley was clean and of good appearance, but it had suffered from insect attack, about 16 per cent. of the grains being affected. The grains, when cut across, were on the whole somewhat flinty.

The barley, as received at the Imperial Institute, was examined with the following results:

	Per cent.
Germinating power (4 days)	86
" " (9 days)	89
Moisture	11·2
Nitrogen:	
Total	1·2
Albuminoid	1·0
Fat	1·5
Average weight of 1,000 grains	58 grams.

The grains which did not germinate after nine days, amounting to 11 per cent. of the total, had been attacked by insects.

The sample was submitted to an expert in London, who reported that it represented a good malting barley, which should be readily saleable in the United Kingdom if it could be marketed in commercial quantities. The current value of consignments equal to the sample would be about 30*s*. per quarter of 448 lb. on rail in London (July 1914). The expert, however, expressed a doubt as to whether the quality of shipments of the barley could be kept up to the standard of the present sample.

This barley contained a low percentage of nitrogen, which is a good feature in a malting barley, but owing to the attacks of insects the germinating power of the present sample is rather low.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

NEW DEVELOPMENTS IN THE WORK OF THE IMPERIAL INSTITUTE

I. Formation of a Technical Information Bureau

For some years past a steadily increasing stream of enquiries has been received by the Imperial Institute from manufacturers, merchants, and others in Great Britain, India, and the Colonies. These enquiries relate principally to new sources of supply of raw materials, methods of utilising new products from the Colonies and India, or to new or little known processes and machinery for industrial purposes. The number of these enquiries has now become so great that the Secretary of State for the Colonies has authorised the formation of a Technical Information Bureau at the Institute for dealing with them.

This Bureau has already been at work for some months. It is a special branch of the Scientific and Technical Research Department, and is mainly staffed by experts who have had the advantage of experience in the work of that Department, which is carried on in communication with producers in the Colonies and with manufacturers and users of raw materials in this country.

The present is a specially opportune time for the formation of such a Bureau, since the paralysis of German and Austrian trade and industry opens up opportunities for the development of many industries in this country and in the Colonies which have hitherto been monopolised by Germany. Apart from its general activity the Bureau is already playing a part in this special work, and some instances may be given to illustrate the kind of assistance it is prepared to render.

A very important question at the present moment is that of the supply of potash salts, which are essential in certain branches of glass and soap manufacture and for the preparation of a large number of chemicals and

manures. Germany has for many years had a practical monopoly of this industry, owing to her possession of the great potash mines of Stassfurt. The only country which has made any attempt to break this monopoly is the United States. The possible sources of supply of potash to Great Britain just now are small, being limited to imports of nitre from India, potash made from Irish and Scotch kelp, and a little obtained as by-products from wool and waste timber. Numerous enquiries have been received at the Imperial Institute from British manufacturers on this subject, and they have been placed in communication with firms who may be able to meet their requirements to some extent. It is quite certain, however, that the existing supplies outside Germany are quite inadequate to meet all the demands, and the Bureau is preparing a statement as to the sources of potash, which will include some hitherto almost untouched for industrial purposes. The necessary enquiries will occupy some time, but it is hoped to issue the statement shortly.

An equally important matter is that of finding markets in this country for the immense quantities of raw materials from India and the Colonies formerly exported to Germany and to other countries of the enemy. As examples of these materials, palm kernels and copra may be mentioned. These products have been exported on a very large scale to Germany to be worked up into oil and feeding-cake, the former being then largely exported to England. There is no reason why this industry should not be transferred to such great oil-seed crushing centres as Hull and Liverpool, and the Bureau is prepared to place manufacturers in communication with merchants dealing in palm kernels, copra, and other raw materials of all kinds.

A statement giving full information regarding the German palm kernel industry was published in the last issue of the BULLETIN, whilst the present number contains further information on the subject (p. 577) as well as a comprehensive article on copra and its utilisation (p. 557).

Similar detailed statements, prepared in the Technical Information Bureau, will be published in this BULLETIN

from time to time. In addition, special circulars calling attention to Colonial and Indian raw materials of technical interest to British manufacturers will be issued as required, and distributed to all manufacturers likely to be interested. The following circulars of this kind are now available:

1. New markets for British, Colonial, and Indian copra.

2. Wattle or mimosa bark for tanning.

Written enquiries for copies of these circulars and for information should be addressed to the Director, Imperial Institute, South Kensington, S.W., and marked "Technical Information Bureau."

II. The Conduct of Special Investigations and Enquiries for Manufacturers and Producers

Until recently the experimental investigations and analyses carried on by the Scientific and Technical Research Department of the Imperial Institute have been limited to subjects and materials submitted officially by British, Colonial, or Indian Government Departments.

Every year, however, a number of requests are received from manufacturers in the United Kingdom, and from planters and others in the Colonies and India, desiring to find openings for raw materials, for assistance in the investigation of the composition and value, and the methods of preparing or utilising raw materials, both mineral and vegetable. Wherever possible these enquirers are referred to professional experts who can give them the assistance they require, but in many cases this cannot be done. To meet these cases the Secretary of State for the Colonies has sanctioned a scheme whereby special analyses and investigations of this kind can be undertaken at the Imperial Institute for firms or private persons in any part of the Empire, on payment of appropriate charges.

All reports made under this scheme will be the property of the person or firm requesting them, and their contents will not be communicated or published in any form without the consent of those concerned.

All requests for such work should be addressed in writing to the Director, Imperial Institute, South Kensington, S.W.

ATIVE LIBRARY CHICAGO

THE INDUSTRIAL POSITION OF COPRA, COCONUT OIL, AND COCONUT CAKE

Large quantities of coconut oil are produced by natives in India, Ceylon, and elsewhere, whilst the dried kernels of the coconut, known as copra, are largely exported to Europe, and the oil extracted by modern milling methods. Prior to the war the chief countries importing copra were Germany and France, but owing to the complete cessation of trade from British possessions to the former country, as well as to Austria-Hungary, large quantities of copra from Ceylon, India, the Federated Malay States, and other countries have become available for use elsewhere, and in the present article attention is called to the magnitude of this trade and to the desirability of British merchants and manufacturers securing a larger proportion of copra for industrial purposes in this country.

The quantities and values of the exports of copra from some of the more important producing countries are shown in the following table; the figures in each case are for the last year for which statistics are available:

	Year.	Quantity. cwts.	Value. £
British Territories:			
Ceylon	1913	1,117,292	1,397,284
India	1913-14	763,832	1,039,826
Federated Malay States	1913	185,753	211,043
Seychelles	1913	58,738	71,919
Tongan Islands Protectorate	1912	222,400	209,567
Fiji Islands	1913	158,585	176,741
Papua	1912-13	15,880	16,356
British Solomon Islands	1912-13	83,920	73,637
Gilbert and Ellice Islands Protectorate	1911	41,700	20,700
East Africa Protectorate	1912-13	31,283	31,956
Zanzibar	1913	—	216,842
Gold Coast	1913	12,589	14,291
Trinidad	1913	10,308	11,545
Foreign Territories:			
Philippine Islands	1913	1,618,080	1,988,692
Java	1913	1,556,000	—
Sumatra (East Coast)	1912	80,860	—
Celebes	1913	580,340	—

	Year.	Quantity. cwts.	Value. £.
Indo-China	1912	157,074	95,783
New Caledonia	1912	53,173	64,850
French Oceania	1912	117,662	112,569
Samoa	1912	220,423	203,496
Bismarck Archipelago, German Solomon Islands, and German New Guinea	1912	223,814	202,603
East Carolines, Marshall Islands, and Nauru	1912	94,940	82,820
West Carolines, Pelew and Mariana Islands	1912	21,706	15,091
German East Africa	1912	83,468	78,152
Portuguese East Africa	1911	78,820	48,066

The following tables, giving the distribution of the exports of copra from British possessions, show that in many cases a very large proportion of the trade was with Germany; in the case of Ceylon no less than three-quarters of the exports went to Germany in 1913, and in the case of India in 1912–13 as much as four-fifths.

Ceylon

	1911.		1912.		1913.	
	cwts.	£	cwts.	£	cwts.	£
United Kingdom	10,503	9,382	9,996	10,804	1,500	2,001
India	56	27	—	—	163	244
Austria-Hungary	12,096	13,120	29,977	31,956	30,041	37,518
Belgium	14,508	14,439	4,020	2,445	18,000	23,422
Denmark	11,500	14,133	68,000	79,285	25,667	34,639
France	7,999	7,934	2,000	2,200	1,003	1,000
Germany	567,473	612,312	368,034	408,525	814,979	1,013,486
Holland	1,000	1,000	1,000	1,067	1,059	1,200
Roumania	—	—	—	—	4,000	5,600
Russia	191,171	200,341	131,042	135,893	220,880	278,174
United States	5,508	5,500	—	—	—	—
Total	821,814	878,188	614,089	672,175	1,117,292	1,397,284

India

	1910-11.		1911-12.		1912-13.	
	cwts.	£	cwts.	£	cwts.	£
United Kingdom	5,929	7,013	40,814	51,865	43,999	54,318
British Possessions	1,771	1,490	847	834	753	852
Russia	24,856	29,323	31,485	36,373	43,184	54,886
Germany	348,556	409,359	473,292	563,168	548,331	687,142
Holland	1,997	2,663	12,735	15,866	8,492	10,258
Belgium	11,360	13,250	25,485	29,718	13,904	15,889
France	54,401	61,994	48,490	56,920	26,049	32,367
Other countries	757	1,043	4,375	4,914	2,281	3,153
Total	449,627	526,135	637,523	759,658	686,993	858,865

Federated Malay States

Most of the copra exported from the Federated Malay Straits is sent to the Straits Settlements, but no information is available as to its ultimate destination. The total exports in recent years are as follows:

	cwts.	£
1910	149,726	139,326
1911	160,790	151,002
1912	154,204	152,036
1913	185,753	211,043

Protected Malay States

A considerable amount of copra is produced in the States of Perlis, Kelantan, Trengganu, and Johore. No statistics of the exports from the last-named State are available, but in 1912, 161,648 cwts., valued at £157,548, were imported into Singapore from Johore. The exports from the other States mentioned in the last year for which statistics are available were as follows:

	Year	*cwts.*	£
Perlis	1911	5,146	—
Kelantan	1912	90,995	89,176
Trengganu	1912	27,715	28,044

Straits Settlements

There is a very considerable transit trade in copra in the Straits Settlements, and large quantities are exported to Europe from Singapore and Penang. That shipped from the former port is derived mainly from the Netherland East Indies, Malay Peninsula, Philippine Islands, and Siam, whilst that shipped from Penang comes chiefly from the Netherland East Indies and Malay Peninsula. The total exports from Singapore and Penang in 1912 were as follows:

	Singapore.		Penang.	
	cwts.	£	*cwts.*	£
United Kingdom . .	41,774	45,205	11,431	14,308
Austria-Hungary . .	62,127	64,550	4,981	5,577
Belgium	28,600	30,081	1,001	1,027
Denmark	94,742	102,823	75,330	81,863
France	172,531	179,820	21,414	23,317
Germany	402,643	420,934	258,026	290,332
Russia	304,969	317,868	55,571	60,170
Other countries . . .	72,257	74,965	3,010	2,648
Total	1,179,643	1,236,246	430,764	479,242

British North Borneo

No information is available as to the destination of the copra exported from British North Borneo. The quantity and value of the total exports in recent years are as follows:

	cwts.	£
1910	9,237	7,331
1911	10,571	8,532
1912	11,200	9,076
1913	12,884	11,504

Seychelles

	1911.		1912.		1913.	
	cwts.	£	cwts.	£	cwts.	£
United Kingdom . . .	2,210	2,107	799	813	10,521	14,127
France	37,326	37,995	46,083	46,619	44,106	52,772
Germany	11,414	11,325	6,963	5,981	2,368	2,757
Other countries . .	20	19	—	—	1,743	2,263
Total . . .	50,970	51,446	53,845	53,413	58,738	71,919

Tongan Islands Protectorate (Friendly Islands)

	cwts.	£
1910	259,960	232,866
1911	254,420	231,479
1912	222,400	209,567

No particulars are available as to the destination of the exports in 1911 and 1912, but in 1910 about one quarter of the total output was shipped to Europe, the balance going to Australia, with the exception of a small quantity which went to New Zealand.

Fiji Islands

	1911.		1912.		1913.	
	cwts.	£	cwts.	£	cwts.	£
United Kingdom . . .	—	—	49,099	45,354	34,747	36,518
Australia	257,814	233,915	207,841	180,780	122,352	138,663
New Zealand	68,916	60,330	16,230	14,899	—	—
Canada	—	—	1,040	1,040	—	—
United States	—	—	—	—	1,483	1,557
Japan	—	—	—	—	3	3
Total . . .	326,730	294,245	274,210	242,073	158,585	176,741

Papua

No information is available as to the destination of the copra exported from Papua. The total exports in recent years are as follows:

	cwts.	£
1910–11	21,204	17,837
1911–12	19,860	19,368
1912–13	15,880	16,356

British Solomon Islands

The total exports of copra from the British Solomon Islands in recent years are given in the following table. No information is available as to the countries of destination.

	cwts.	£
1910–11	80,600	68,999
1911–12	71,740	55,953
1912–13	83,920	73,637

Gilbert and Ellice Islands Protectorate

The estimated total exports of copra in 1910 amounted to 60,000 cwts., valued at £30,000. In 1911 the exports were 41,400 cwts., valued at £20,700.

East Africa Protectorate

	1910–11.		1911–12.		1912–13.	
	cwts.	£	*cwts.*	£	*cwts.*	£
United Kingdom	—	—	403	412	405	468
Zanzibar	5,402	4,347	3,534	2,966	3,624	3,620
France	30,207	25,387	27,780	24,677	26,524	27,151
Other countries	1,270	874	—	—	730	717
Total	36,879	30,608	31,717	28,055	31,283	31,956

Zanzibar

	1911.	1912.	1913.
	£	£	£
United Kingdom	25	298	—
France	199,155	189,915	215,063
Germany	2,603	624	1,779
Italy	1,325	—	—
Other countries	838	100	—
Total	203,946	190,937	216,842

Of the total exports from Zanzibar in 1913, 142,019 cwts., valued at £162,632, were produced in the Protectorate, most of the remainder being derived from German East Africa.

Gold Coast

	1911.		1912.		1913.	
	cwts.	£	*cwts.*	£	*cwts.*	£
United Kingdom	54	36	99½	69	45	39
France	13,950	11,987	11,617	11,256	12,394	14,136
Germany	1,593	1,234	679	514	150	116
United States	—	—	2½	2	—	—
Total	15,597	13,257	12,398	11,841	12,589	14,291

Nigeria

	1911.		1912.		1913.	
	cwts.	£	*cwts.*	£	*cwts.*	£
United Kingdom	2	1½	28	28	203	203
French Possessions	1,740	1,542	825	740	—	—
Germany	196	129	1,041	861	1,732	1,688
Total	1,938	1,672½	1,894	1,629	1,935	1,891

Trinidad

	1911.		1912.		1913.	
	cwts.	£	*cwts.*	£	*cwts.*	£
United Kingdom	10,068	8,772	9,323	10,138	7,979	8,936
Germany	3,523	3,216	13,101	12,298	1,637	1,834
United States	1,249	1,276	5,793	6,290	692	775
Total	14,840	13,264	28,217	28,726	10,308	11,545

Jamaica

	1910.		1911.		1912.	
	cwts.	£	*cwts.*	£	*cwts.*	£
United Kingdom	286	294	199	263	408	610
Germany	—	—	—	—	4	5
United States	—	—	—	—	10	10
Total	286	294	199	263	422	625

British Guiana

	1910-11.		1911-12.		1912-13.	
	cwts.	£	*cwts.*	£	*cwts.*	£
United Kingdom	584	470	1,426	1,364	1,143	1,101
British West Indies	—	—	—	—	1½	1½
Denmark	113	62	—	—	—	—
Germany	—	—	223	207	—	—
United States	21	20	—	—	4½	5
Total	718	552	1,649	1,571	1,149	1,107½

Small quantities of copra are also exported from some other British Possessions, the total exports in each case in 1912 being as follows:

	cwts.	£
Mauritius	167	86
Grenada	252	182
St. Lucia	69	68
British Honduras	18	8½

Figures for the total imports of copra to Germany are not available, but as Harburg near Hamburg is the chief centre of the German oil-seed crushing industry it is probable that the figures for the latter port represent nearly the total German imports.

Imports of Copra in 1913 to Hamburg and Austria-Hungary

	Quantity, metric tons (2,204 lb.).
Hamburg:	
Imports from all sources	230,395
,, ,, British Possessions	124,434
Austria-Hungary:	
Imports from all sources	33,604
,, ,, British Possessions	29,177

The details of the imports from the British Empire are as follows:

Imports of Copra in 1913 to Hamburg and Austria-Hungary from the British Empire

	Hamburg, metric tons (2,204 lb.).	Austria-Hungary, metric tons (2,204 lb.).
United Kingdom	225	—
British Central and South America	195	—
British Africa	(not given)	774
British East Indies	112,341	22,104
Australia	10,653	6,299
British South Sea Islands	1,020	
	124,434	29,177

These figures are not quite complete. Some imports from British West Africa reach Hamburg, but are not separately shown in the returns for that port. The imports from Australia to Austria-Hungary include 608 metric tons from British Australia, and 5,691 metric tons described merely as from Australia, which probably includes some from foreign possessions in the Pacific Ocean.

The quantity of British copra for which a new market must be found may therefore be taken as about 153,611 metric tons.

It seems likely that a considerable proportion of this can be taken by the United Kingdom. The copra imported into Germany and Austria-Hungary is used for the production of oil (coconut oil) and feeding-cake (coconut cake). Of the coconut oil expressed from copra in or near Hamburg in 1913, the quantity exported as coconut oil amounted to 40,966 metric tons, of which 30,236 metric tons was sent to the United Kingdom and 5,261 metric tons to Norway and Sweden, the next largest purchasers. Copra is already expressed for oil in the United Kingdom and coconut oil is made both in Ceylon and India. The oil now produced in Hamburg for the United Kingdom might be expressed in Ceylon or India and shipped direct, or the copra might be exported to the United Kingdom and treated here instead of in Hamburg.

The exports of coconut oil from Germany to the United Kingdom before the war are stated to have been largely the produce of a British-owned factory in Germany.

The Trade Returns for the United Kingdom show that in 1913 this country also imported about 18,600 metric tons of coconut oil from foreign countries other than Germany. The total imports of foreign coconut oil to the United Kingdom in 1913 therefore amounted to about 49,000 metric tons, corresponding to about 82,000 tons of copra.

It is moreover certain that from all these foreign countries which export coconut oil to the United Kingdom, and especially from Germany, considerable quantities of coconut oil also reach this country in the form of margarine, vegetable butter, and prepared fats and foods of

various kinds. No definite figures can be suggested for the amount received in this way.

It is clear from the foregoing data that considerably more than half of the British copra hitherto exported to Germany and Austria-Hungary might be taken by the United Kingdom for home use, either in the form of copra or coconut oil. Ceylon and India produce both copra and coconut oil, so that these countries could probably divert their supplies in either form to the United Kingdom. It is understood moreover that firms crushing copra in the United Kingdom are now extending their plant so that their is a good prospect of the British market for copra being greatly enlarged.

In addition to the possibility of finding a market in the United Kingdom, there appears to be a considerable chance of the British Colonies and India securing a share of the French import trade in copra. In 1912 the total imports of copra into France were 153,506 metric tons. Of this 19,691 metric tons came from British Possessions, and 10,321 metric tons from French Colonies. Of the remainder 43,422 metric tons came from the Netherland East Indies and 72,964 metric tons from the Philippines. It ought to be possible for Ceylon, India, and the Federated Malay States to compete on favourable terms with the Netherland East Indies and the Philippines for this trade.

Apart from the United Kingdom and France the new markets available for British copra are small. In the case of the United States the imports of copra in 1913 amounted to 15,548 metric tons, of which 10,674 metric tons came from the Philippines, and the rest mainly from French, British, and German Possessions in the Pacific. The imports of coconut nut oil to the United States amounted in 1913 to 22,915 metric tons, of which about 18,000 metric tons came from Ceylon, India, the United Kingdom, and Australia, and the rest chiefly from France, Germany, and the Philippines.

In Holland it may be difficult to replace the imports from the Netherland East Indies by British copra and coconut oil, but there seems to be some possibility for the development of export to Denmark, Scandinavia, and Russia.

Uses and Value of Copra

The copra imported to Europe and elsewhere is used as a source of oil (coconut oil) and feeding-cake (copra or coconut cake). The methods of preparing copra have been dealt with already in this Bulletin in an article on the coconut and its commercial uses (1912, **10**, 274), and it is proposed to deal now merely with its utilisation and value. The copra exported from the different countries varies somewhat in quality; the values of the more important grades in London, Marseilles, and Hamburg are shown below:

	London (Jan. 21, 1915), per ton.	Marseilles (July 17, 1914), per 100 kilos.
	£ s. d.	*frs.*
Malabar	26 2 6	—
Ceylon	25 10 0	63
Malay and Straits	£24 0 0–£24 10*s.* 0	59·50
Zanzibar	—	59·50
Manila	23 12 6	58·50
Samoa	23 17 6	59·50
East Africa	24 5 0	—

Coconut Oil

As already mentioned, large quantities of coconut oil are prepared from the fresh kernels in Ceylon and India, the exports in recent years being as follows:

Exports of Coconut Oil from Ceylon

	1911.		1912.		1913.	
	cwts.	£	*cwts.*	£	*cwts.*	£
United Kingdom	258,664	448,868	167,586	294,393	150,650	307,326
British Possessions	2,120	3,679	1,789	3,143	2,261	4,612
Austria-Hungary	16,253	28,204	17,975	31,576	14,300	29,172
Belgium	10,247	17,782	2,804	4,926	4,407	8,990
France	119	206	—	—	5	10
Germany	16,960	29,431	5,306	9,321	1,712	3,493
Holland	2,038	3,537	1,441	2,531	3,116	6,357
India (other than British)	952	1,652	1,092	1,918	1,203	2,454
Italy	852	1,478	2,046	3,594	2,311	4,715
Mozambique	3,001	5,208	441	775	276	563
Norway	12,072	20,949	31,423	55,200	40,626	82,877
Russia	—	—	—	—	401	818
Sweden	3,998	6,938	3,779	6,638	3,411	6,958
United States	177,731	308,422	166,053	291,700	322,305	657,502
Other foreign countries	9	16	44	77	—	—
Total	505,016	876,370	401,779	705,792	546,984	1,115,847

Exports of Coconut Oil from India

	1910-11.		1911-12.		1912-13.	
	Gals.	£	Gals.	£	Gals.	£
United Kingdom . .	317,670	39,363	557,292	72,076	217,655	29,499
British Possessions .	41,295	5,742	59,117	8,133	48,174	6,811
Sweden . . .	191,171	21,763	316,295	40,998	99,385	13,217
Germany . . .	711,434	84,208	584,251	65,469	163,940	20,929
Holland . . .	30,887	3,590	60,306	7,772	39,337	5,017
Belgium . . .	103,326	12,503	34,506	4,507	46,229	6,189
United States . .	485,567	58,575	477,487	62,080	327,899	43,644
Other foreign countries	53,258	6,899	75,849	9,777	26,875	3,715
Total . . .	1,934,608	232,643	2,165,103	270,812	969,494	129,021

Nearly all the Indian oil is prepared in Madras, and particularly on the Malabar coast. The Cochin oil produced in the latter region is on the whole more carefully prepared than Ceylon oil, and consequently realises higher prices. The values of Cochin and Ceylon oils in London at the present time are £55 and £48 10*s.* per ton, respectively (February 1915).

The quality of the oil prepared by expression from copra in Europe, the United States, and elsewhere depends largely on the quality of the copra used. Sun-dried copra yields an oil of paler colour than kiln-dried copra, whilst that obtained from imperfectly dried copra is of higher acidity and inferior quality. The current value of London-expressed oil is £40 5*s.* per ton (February 1915). The oil content depends on the thoroughness with which the copra has been dried. Thus, sun-dried kernels contain about 50 per cent. of oil, kiln-dried kernels contain 63 to 65 per cent., and hot-air-dried copra up to as much as 74 per cent. The ground copra is expressed twice at a temperature of 55° to 60° C., the yield of oil from average copra being about 62 to 63 per cent.

At the average European temperature coconut oil is a solid fat, varying in colour from white to yellowish, according to the quality of the copra and the method of preparation. The unrefined oil prepared from the best quality copra possesses the characteristic smell and taste of the fresh coconut, but that obtained from the lower grades of copra is often rancid and disagreeable in smell and taste. By suitable refining methods, however, an

odourless and tasteless oil may be produced, and the refining of coconut oil for the production of edible fats is now an important industry. The following table gives the range of the principal constants of coconut oil.

Specific gravity at $\frac{99^\circ C.}{15^\circ C.}$		0·874
Iodine value	*per cent.*	8·0–10·0
Saponification value		246–268
Hehner value		82·4–90·5
Reichert-Meissl value		6·6– 7·5
Polenske value		18·0
Titer test		21·2° C.–25·2° C.

Refined coconut oil is used in the preparation of solid edible fats such as margarine, vegetable butters, cooking fats, and chocolate fats, as well as in the manufacture of cakes, biscuits, sweetmeats, etc. In order to obtain a fat of firmer consistence and higher melting point, a certain proportion of the liquid constituents of the oil ("coconut olein") is removed by expression. The "coconut stearin" which is left is used for the purposes indicated above, when obtained from high-grade oil, while that obtained from the lower grades is used for candle manufacture. The extent of the trade in coconut oil and the edible products obtained from it has already been referred to (see p. 564).

Feeding Trials with Coconut Cake and Meal

Coconut cake, which is left after expression of the oil from copra, is of value as a cattle food, either as such or when ground in the form of meal. The cake is usually of a pale brown colour. It has a pleasant nut-like smell and taste, and is readily eaten by all classes of animals. It is used largely in Germany as a feeding stuff for live-stock, but owing to its relatively high price in that country it is generally given only to milch cows.

Numerous feeding experiments with the cake or meal have been carried out in Germany, the United Kingdom, and elsewhere. In the case of milch cows the results almost without exception show that feeding with coconut cake increases the percentage of fat in the milk; its precise

effect on the milk yield, however, seems to be in some doubt. Hansson (*Fühling's Landw. Zeit.*, 1912, **61**, 337), in commenting on the results of feeding trials reported from several sources, concludes that coconut cake tends to increase milk secretion, and as a result of experiments carried out on milch goats in Germany it was concluded that the cake contains substances which exercise a stimulating effect on the mammary glands (*Landw. Vers. Stat.*, 1909, **71**, 373). Experiments carried out at the South-Eastern Agricultural College, Wye, however, showed that when coconut cake replaced other concentrated foods the quantity of milk produced was slightly decreased (*Journ. S.E. Agric. Coll.*, 1911, No. 20, p. 47), and similar results were obtained at the Midland Agricultural and Dairy College, Derby. In the latter experiment eight cows were fed on rations containing either coconut cake, undecorticated cotton-seed cake, or linseed cake. The total milk yield from the eight animals fed for a fortnight on each cake were as follows:

	lb.
Linseed cake	2,472½
Coconut cake	2,429
Undecorticated cotton-seed cake	2,428½

In these experiments, the live-weight increase was greatest during the period when coconut cake was used, whilst the butter produced during this period was better flavoured, of firmer texture, and appeared to possess better keeping qualities than in the other cases, whilst the results are stated to have been financially in favour of coconut cake. The fact that coconut cake tends to produce a firm butter was also proved in the feeding trials at Wye and in experiments in Germany. Coconut cake should therefore be of special value for feeding to milch cows during warm weather and for use with foods, such as crushed oats and maize, wheat bran, rice meal, rape, sesame, and sunflower seed cakes, all of which tend to produce a soft butter. The quantity fed to milch cows should not exceed 4½ to 5 lb. per head per day, as larger quantities tend to produce a hard butter with a tallowy taste.

According to the *Report of the Agricultural Experiment Station, California*, for 1895–96, coconut meal is "a much valued concentrated food and is finding more favour every year with the dairymen of California. Whilst not rating as high in flesh formers as either linseed or [decorticated] cotton seed meal, it appears in many cases to be more relished by the animals."

The feeding value of coconut cake as compared with linseed cake for fattening cattle was investigated by the Edinburgh and East of Scotland College of Agriculture in 1911–12. Each cake was fed at the rate of 4 lb. per head per day, the basal ration consisting of 4 lb. Bombay cotton cake, 90 lb. swedes, and 12 lb. oat straw. All the animals, with one exception, ate the coconut cake readily after it had been steeped in twice its weight of water, and this one exception took the allowance in the dry form quite readily. The beef produced was of high quality. From the results of the experiments it is concluded that the consuming value of coconut cake (*i.e.* the market value less the value of the manurial residues) is 62·6 per cent. of that of linseed cake (*Report* 27, 1912, *Edin. and E. of Scot. Coll. of Agric.*).

Coconut meal forms a valuable food for pigs and can be used with advantage to counteract the effect of other foods which tend to give a soft oily bacon. It is already used very extensively in some parts of Ireland for pig-feeding, but experiments carried out by the Department of Agriculture for Ireland in 1909–10 seemed to indicate that coconut meal is not worth the extra price paid for it over and above the price of the ordinary meals generally used for this purpose (*Journ. Dept. Agric. Ireland*, 1910–11, **11**, 303).

Coconut meal has also been shown to be of value for feeding horses. Experiments conducted by the French War Department some years ago showed that coconut meal was equal or even superior to the same weight of oats, whilst satisfactory results were obtained in the United States with yearlings and heavy-work horses, when either one half or the whole of the oats in the ration were replaced by an equal weight of a mixture

consisting of two parts coconut meal and one part ground nut meal (*Circ.* 168, 1911, *Bur. Anim. Indust., U.S. Dept. Agric.*).

From the results of the numerous feeding trials referred to in the preceding pages, the following conclusions may be drawn:

1. Coconut cake forms an excellent feeding-stuff for milch cows, when fed at the rate of 4½ lb. to 5 lb. per head per day. It tends to produce a firm butter and is thus especially well suited for feeding during warm weather and to counteract the effect of feeding stuffs which tend to give a soft butter. The results so far as its effect on the milk yield is concerned appear to be inconclusive, and further trials to elucidate this point are necessary.

2. The cake may be safely fed to fattening cattle at the rate of about 4 lb. per head per day, without detriment to the animal or the quality of the meat.

3. The meal is suitable as a food for pigs, but owing to its relatively high price compared with meals usually used for pig feeding, it is doubtful whether it could be employed profitably for this purpose.

4. With regard to the feeding value of coconut meal for horses, it has been shown that it can replace an equal weight of oats in a ration without adversely affecting the animal.

Composition and Value of Coconut Cake as compared with other Feeding-Cakes

In comparing the value of different feeding-stuffs, it is necessary to ascertain their composition, digestibility, "productive value," and the value of the manurial residues arising from their consumption. This subject is fully dealt with in *Leaflet No. 74 Bd. of Agric. and Fisheries*, and only the salient points are considered here.

The constituents of a feeding-stuff comprise water, crude proteins (albuminoids), fat, carbohydrates, crude fibre, and ash.

Water.—In the case of oil-cakes the amount of water present is of importance, as most of them easily undergo

decomposition if they contain more than about 14 per cent. A good cake should contain about 10 per cent. of water.

Crude Proteins.—Under this heading are included all the nitrogen-containing substances, the most important of which are the true proteins, whose chief function in the animal economy is to supply material for the formation of flesh or muscle. Proteins also help to maintain the heat of the animal and to supply energy, and any excess may be employed in the production of fat. The "crude proteins" also include small quantities of amides. The latter are greatly inferior in feeding value to true proteins; but as they are present only in very small quantities in oil-cakes, they can be left out of consideration in estimating the value of the latter, and the whole of the nitrogen-containing substances may be regarded as flesh-formers for present purposes.

Fat.—The chief function of fat is to supply heat to the animal body, but when sufficient has been consumed to maintain the temperature of the body, fats may be converted into animal fat, and so increase the body-weight.

Carbohydrates. — This term includes starch, sugar, mucilage, and some other similar substances. They are the most important sources of animal heat and energy, but for the former purpose fat is nearly two and a half times as valuable, weight for weight. When fed in large quantities the carbohydrates are capable of producing animal fat.

Crude Fibre.—This includes substances of a more or less woody nature, and consists essentially of cellulose mixed with highly indigestible matter.

Ash.—This includes mineral matter, such as potash, lime, phosphoric acid, etc., which form an integral part of the plant from which the feeding-stuff is derived, as well as impurities such as sand, dirt, etc. Oil-cakes as a rule contain an ample supply of the mineral constituents which are necessary to the animal, and the ash may therefore be left out of consideration in comparing their value.

The following table shows the composition of a sample

of English-made coconut cake compared with that of feeding-cakes in common use in this country.

Crude Nutrients

	Moisture.	Crude proteins.	Fat.	Carbohydrates (by difference).	Crude fibre.	Ash.	Nutrient ratio.	Food units.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		
Coconut cake, English (expressed)[1]	8·5	24·5	8·3	39·8	12·8	6·1	1 : 2·42	122
Linseed cake, English made, average (expressed)[2]	11·16	29·50	9·50	35·54	9·10	5·20	1 : 1·94	133
Linseed meal (extracted)[2]	13·15	34·75	3·03	34·67	8·75	5·65	1 : 1·20	129
Decorticated cotton-seed meal, Atlantic Ports (expressed)[2]	7·40	42·37	10·16	25·86	7·06	7·15	1 : 1·16	157
Undecorticated cotton-seed cake, English made (expressed)[2]	13·75	24·62	6·56	29·28	21·19	4·60	1 : 1·67	107

[1] *Analysis made by the Agricultural Analyst for the County of Wilts* (1912).
[2] *Quoted from Smetham* ("*Journ. Roy. Lancs. Agric. Soc.*," 1914).

In discussing the feeding value of different kinds of cake it is desirable to decide on a unit of comparison which will take into account the food values of all the different constituents of a cake, and thus enable the total feeding value of one cake to be compared with that of another by a simple numerical ratio. Such a unit may be arrived at in the following way.

As the various food constituents have different functions to perform, it follows that they will not all be of equal value to the animal. In calculating the food value of a cake the crude proteins and fat may be regarded as two and half times as valuable as the carbohydrates. Consequently the food value (expressed in food units) may be calculated by adding two and a half times the sum of the percentages of crude proteins and fat to the percentage of carbohydrates. The figures thus obtained are shown

in column 9 of the table on page 573. They are quite useful in comparing different samples of the same kind of cake.

In comparing different kinds of cake the crude value so arrived at needs to be qualified by taking into account the different digestibilities of the similar constituents of different cakes: thus the proteins of linseed cake are different from the proteins of cotton-seed cake and have different digestibilities and therefore different food values to the animal fed with them. Further, in the case of those cakes which contain a comparatively large amount of indigestible fibre, the whole of the digestible constituents are not available for meat or milk production. In calculating the food value on this basis the proteins are taken as equal in value to the carbohydrates, but the fat as two and a half times as valuable, whilst the amount of crude fibre is also taken into consideration. The food value (expressed in food units) in this case is found by adding two and a half times the percentage of digestible fat to the percentages of digestible crude proteins, carbohydrates, and crude fibre, the indigestibility of the fibre being allowed for by deducting from the figure thus obtained one unit for every 3 per cent. of crude fibre present. The figures thus obtained are shown in the following table, which also shows the percentage of digestible nutrients in samples of cakes and meals.

Digestible Nutrients[1]

	Crude proteins. *Per cent.*	Fat. *Per cent.*	Carbo-hydrates. *Per cent.*	Crude fibre. *Per cent.*	Food units.
Coconut cake, English (expressed)	19·1	8·1	33·0	8·1	76
Linseed cake, English made, average (expressed)	25·37	8·74	27·72	2·91	75
Linseed meal (extracted) .	29·19	2·88	28·45	4·7	67
Decorticated cotton-seed meal, Atlantic Ports (expressed)	36·44	9·55	17·33	1·98	77
Undecorticated cotton-seed cake, English made (expressed)	18·96	6·1	15·23	3·8	46

[1] *Calculated from the analyses shown in the preceding table (p.* 573), *using the digestibility coefficients of Kellner* ("*The Scientific Feeding of Animals,*" 1909, *pp.* 387, 388).

It will be seen from the above table that when the digestibility of the constituents is taken into consideration, coconut cake compares favourably with cakes in common use for feeding purposes. Although containing less proteins, the high proportion of digestible carbohydrates and fibre bring up the total food units almost to the level of decorticated cotton-seed cake, and slightly above that of linseed cake.

In comparing the cost of the different cakes, allowance must be made for the manurial value of the residues arising from their consumption. If this be deducted from the current value, and the net cost so obtained be divided by the number of food units calculated on a digestibility basis as shown in the table on page 574, the net cost per food unit will be found. This figure will represent the price which the farmer pays for that part of the cake which is actually used for meat and milk production. The current value, value of the manurial residues, and the cost per food unit of coconut cake compared with linseed and cotton-seed cakes, are shown in the following table:

	Current value per ton.	Estimated value of manurial residues arising from the consumption of 1 ton of feeding-stuff.	Cost per food unit, per ton, calculated on the net value, *i.e.* the current value less the estimated value of the manurial residues.
Coconut cake (expressed).	£6 10*s.* to £7 according to quantity and position (London, November 1914).	£1 14*s.* 7*d.*	1*s.* 3*d.* to 1*s.* 4½*d.*
Linseed cake (expressed).	English, guaranteed 95 per cent. linseed, £8 12*s.* 6*d.* to £8 17*s.* 6*d.* (Hull, November 1914).	£2 4*s.* 4*d.*	1*s.* 8½*d.* to 1*s.* 9*d.*
Cotton-seed cake. 1. Decorticated.	American, £8 10*s.* to £8 12*s.* 6*d.* (Liverpool, November 1914).	£3 4*s.* 9*d.*	1*s.* 4½*d.* to 1*s.* 4¾*d.*
2. Undecorticated (both expressed).	English, £5 15*s.* to £6 5*s.* (Liverpool, November 1914).	£1 17*s.* 1*d.*	1*s.* 8*d.* to 1*s.* 10*d.*

It will be seen that when all the factors are taken into account coconut cake is cheaper than linseed or cotton-seed cakes at the rates prevailing recently, and that the difference in price per food unit per ton represents a considerable

advantage to the farmer who uses coconut cake in preference to linseed and undecorticated cotton-seed cakes.

Comparison of English and German Coconut Cakes

Since the crushing of copra was commenced in this country, cakes of higher feeding value have become available. The difference in the composition of cakes produced in England and Germany is fairly considerable, the chief feature being the comparatively low proportion of fibre in English cakes, as is shown in the following table:

	English. 1.	English. 2.	German. (According to Kellner, *loc. cit.*).
	Per cent.	*Per cent.*	*Per cent.*
Moisture	8·5	9·85	10·5
Crude proteins	24·5	23·00	21·4
Fat	8·3	8·00	8·5
Carbohydrates	39·8	44·23	38·7
Fibre	12·8	9·22	14·7
Ash	6·1	5·70	6·2

The analyses of the English cakes have been supplied by the makers of the cakes; No. 1 was made by the Agricultural Analyst of the County of Wilts in 1912; No. 2 is a factory analysis. Samples of British-made coconut cakes may be seen in the Reference Collection of Standard Commercial Products in the Public Exhibition Galleries of the Imperial Institute.

The Trade in Coconut Cake

Particulars as to the extent of the trade in coconut cake and the amount at present employed for feeding purposes are difficult to obtain. Mr. E. W. Thompson, who has recently investigated the trade in cotton-seed products and their competitors in Northern Europe, on behalf of the United States Government, states that 71,000 metric tons of coconut cake were produced in Germany in 1912, of which 30,000 tons were consumed there (*Special Agents Series:* No. 84, *Bureau of Foreign and Domestic Commerce, U.S. Dept. of Commerce*). The exports of coconut cake from Ceylon in 1913 amounted to 236,692 cwts., valued at £72,910; the chief customers were Germany (157,895 cwts., of value £45,629) and Belgium (73,606 cwts., of value £25,677). In 1912–13, 128,074 cwts. of cake, valued at £41,463, were exported from India, and practically the whole of this was sent to Germany. According to Thompson, 12,000 tons of coconut cake were produced in the

United Kingdom in 1912, and 8,000 tons were exported; 9,400 tons were produced in, and 5,000 tons were exported from, the Netherlands in 1912; 10,500 tons were produced in Denmark in 1912, and practically the whole of this was exported. It has been estimated that about 64,000 tons of cake were produced in Marseilles in 1912; it is not exported to any extent from France.

PALM KERNEL CAKE AND MEAL: A NEW FEEDING-STUFF FOR LIVE-STOCK

THE last number of this BULLETIN (1914, **12**, 458) included an article on the "Trade in Palm Kernels," which called attention to the opportunity afforded to British manufacturers by the war to secure a large share of the industry of crushing palm kernels, which has hitherto been carried on in Germany. This article has aroused much interest, and from statements sent to the Imperial Institute by oil-seed crushers, who have already started working palm kernels, or are about to do so, it seems clear that a very large proportion of the palm kernels produced in British West Africa will in future be utilised in Great Britain. In this connection it is interesting to note that 1,600 tons of palm kernels, as well as 3,000 barrels of palm oil, were recently landed at Hull, being the first consignment shipped thence from West Africa.

Two products are obtained in crushing palm kernels, viz. palm kernel oil and palm kernel cake. There seems to be no doubt that the market already existing in this country can take all the palm kernel oil likely to be produced here, but it is by no means certain at present that it will be possible at once to sell all the British-made palm kernel cake in this country. This is not due to the absence of a large British demand for feeding-cakes, but to the fact that farmers in this country are averse to using feeding materials which are new to them. Palm kernel cake is a very popular feeding material in Germany, Holland, Denmark, and Scandinavia, but it is comparatively unknown in Great Britain, and in order that the palm kernel crushing industry may be successfully and per-

manently established in this country it is very desirable that palm kernel cake should be made equally popular with British farmers. Sir Owen Philipps, Chairman of the West African Section of the London Chamber of Commerce, has already arranged with a number of the British agricultural colleges to carry out feeding trials with palm kernel cake, and the reports from the colleges should be of great value in making the qualities of this material known to farmers.

In the previous article published in this BULLETIN the feeding value of palm kernel cake and meal was referred to, and analyses of these products, as made in Germany, were published. Since then the Imperial Institute has been provided by British manufacturers of palm kernel cake and meal with typical analyses of the products they make, and these are now given in the following tables; the German analyses of German-made cake and meal previously quoted are added for comparison. Table I shows the percentage of crude nutrients present, and Table II the amounts of digestible nutrients; the food units in each case are calculated by the methods referred to on pp. 573 and 574 respectively.

TABLE I

Crude Nutrients

	Palm kernel cake (expressed).				Palm kernel meal (extracted).	
	English.			German.	English.	German.
	1.	2.	3.	4.	5.	6.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	12·0	12·0	10·85	9·7	15·0	10·9
Crude proteins	16·75	18·5	16·12	17·7	19·0	18·7
Fat	7·07	5·5	6·17	8·6	2·0	1·6
Carbohydrates	46·83	50·0	48·51	36·2	51·0	39·1
Crude fibre	13·55	10·0	14·80	23·8	9·0	25·4
Ash	3·8	4·0	3·55	4·0	4·0	4·3
Food units	106	110	104	102	104	90

1. Factory analysis (1914).
2. Average of factory analyses taken over a period of three months (1914).
3. Lloyd (*Field*, November 14, 1914, p. 837) (1914).
4. Kellner (*Scientific Feeding of Animals*, p. 377) (1905).
5. Average of factory analyses taken over a period of three months (1914).
6. Kellner (*loc. cit.*).

TABLE II

Digestible Nutrients[1]

	Palm kernel cake (expressed).				Palm kernel meal (extracted).	
	English.			German.	English.	German.
	1.	2.	3.	4.	5.	6.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Crude proteins	12·56	13·88	12·09	13·28	18·05	17·77
Fat	6·93	5·39	6·05	8·43	1·90	1·52
Carbohydrates	36·06	38·50	37·35	27·87	47·94	36·75
Crude fibre	5·28	3·90	5·77	9·28	7·38	20·83
Food units	67	67	65	63	75	71

[1] *Calculated from the analyses shown in Table I, using the digestibility coefficients of Kellner* (*loc. cit.*, p. 388).

It is satisfactory to note that the British-made cakes and meal are without exception superior in quality to the German products. This is especially shown in the lower proportion of crude fibre (so-called indigestible fibre) present in the British cake and meal. Attention has been called to this point in a recent article in the *Journal of the Board of Agriculture* (1914, **21**, 697), where it is attributed to improved methods of crushing. It is, however, much more probable that it is due to the careful removal in the British mills of all fragments of palm-nut shells. The point of importance, however, is that the percentage of crude fibre is very low in the British products, with the result that the feeding value of the cake and meal is correspondingly increased.

Samples of British-made palm kernel cake and meal may be seen in the Reference Collection of Standard Commercial Products in the Public Exhibition Galleries of the Imperial Institute.

THE ECONOMIC RESOURCES OF THE GERMAN COLONIES

I. German East Africa

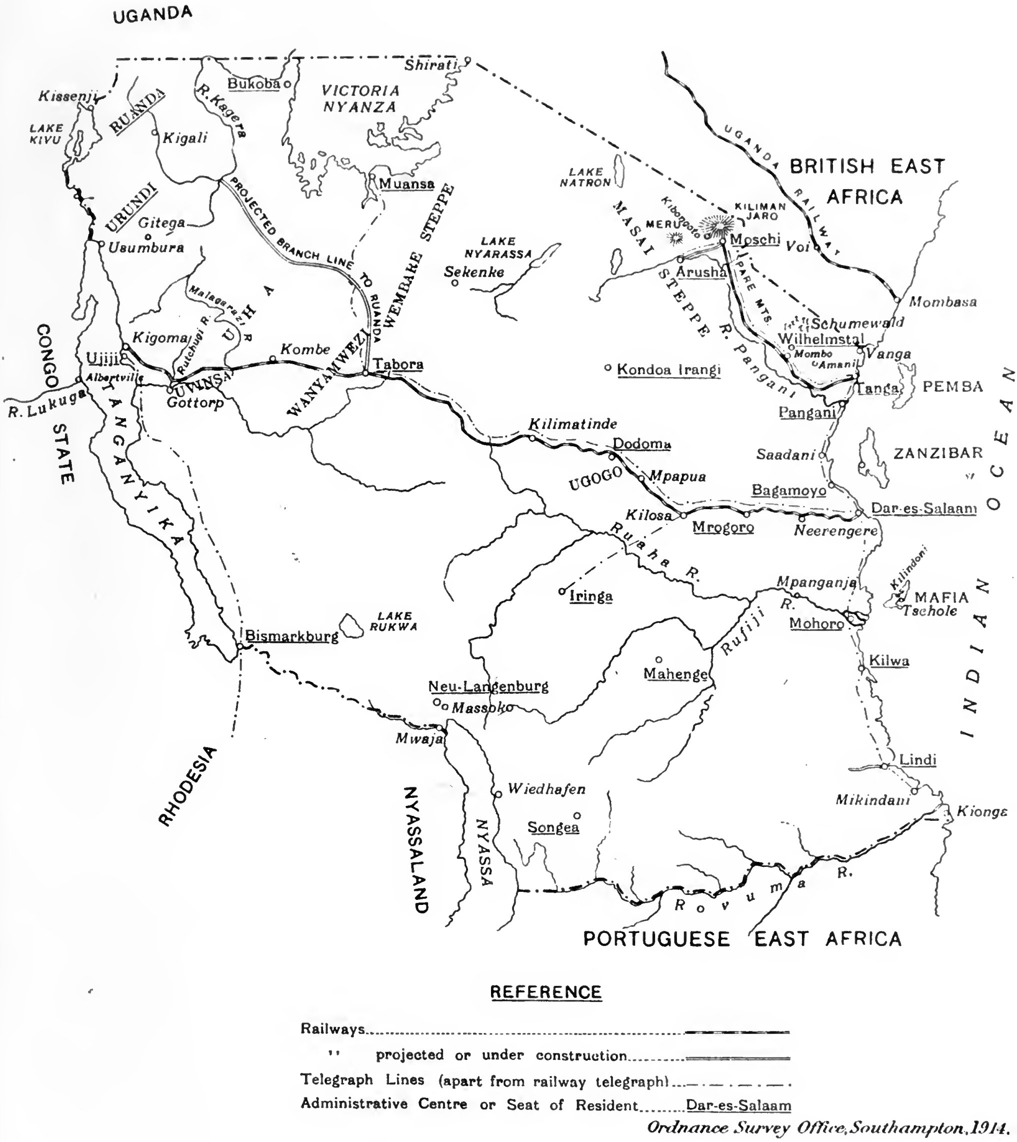
(With a Map)

In a previous number of this Bulletin (1913, **11**, 462) an account was given of the organisation of experimental work in agriculture in the German Colonies. In the present series of articles it is intended to deal with the economic resources of these colonies, with especial reference to the possibilities of further development, commencing with German East Africa.

The Protectorate of German East Africa extends from about 1° to 11° S., and from about 30° to 40° E., and has a total area of 384,169 square miles, *i.e.* more than three times the size of the United Kingdom, and about 30,000 square miles larger than the British East Africa Protectorate. It is bounded on the east by the Indian Ocean, on the south by Portuguese East Africa, on the south-west by Nyasaland and Rhodesia, on the west by the Belgian Congo, and on the north and north-east by Uganda and the British East Africa Protectorate. The coast-line extends from the mouth of the Umba to a few miles south of the mouth of the Rovuma, a distance of about 620 miles. Three large islands lie off the coast, viz. Pemba and Zanzibar, which form the British Protectorate of Zanzibar, and, further south, Mafia with an area of about 200 square miles, which forms part of German East Africa.

The country as a whole is elevated, the interior plateau of Central Africa ending more or less abruptly near the coast, leaving a coastal plain which in the north varies in width from ten to thirty miles, but broadens out further south. The average altitude of the plateau is between 3,000 and 4,000 ft. The highest points in the Protectorate are in the north-east, where the extinct volcano Kilimanjaro, the highest mountain in Africa, situated close to the boundary of British East Africa, rises to 19,321 ft., whilst a little to the west is Mount Meru

SKETCH MAP OF GERMAN EAST AFRICA.



To accompany the article on German East Africa in the BULLETIN OF THE IMPERIAL INSTITUTE, 1914, Vol. XII. No. 4.

(14,955 ft.). Stretching south-eastwards from Kilimanjaro are the Pare and Usambara Mountains, the latter almost reaching the sea. To the south-west of the Usambara hills, and on the eastern edge of the plateau, are the mountainous regions of Nguru, Useguha, and Usagara. In the south-west of the Protectorate are the Livingstone Mountains, where the highest peak is over 9,000 ft.

Portions of the great lakes of Central Africa are included in the Protectorate, viz. the southern portion of Victoria Nyanza, the eastern shores of Lakes Kivu and Tanganyika, and the northern and north-eastern shores of Nyasa. Situated on a line running through the centre of the country from north-east to south-west, are lakes Natron, Nyarassa, and Rukwa.

The country is well watered. The chief rivers draining the plateau and flowing into the Indian Ocean are the Rufiji and the Rovuma. The latter is about 500 miles long and has its source in the mountains east of Nyasa; for the greater part of its length it forms the boundary between the Protectorate and Portuguese East Africa. The Rufiji is navigable by small steamers for about sixty miles from its mouth; whilst one of its southern tributaries, the Ulanga, is navigable almost throughout its whole course. Other rivers entering the Indian Ocean are the Pangani, which has its source in a glacier on Kilimanjaro, and the Wami and Kingani, both of which have their origin on mountains on the fringe of the plateau; none of these is navigable for more than a few miles from its mouth. Of the rivers which feed the great lakes the more important are the Mori and Kagera (Victoria Nyanza), Malagarasi (Tanganyika), Songwe and Ruhuhu (Nyasa), and Saisi and Rupa-Songwe (Rukwa). The Kagera, which is 400 miles long, forms the headwater of the Nile, and is navigable for seventy miles from its mouth.

The chief seaports, all of which have good harbours, are, going from north to south—Tanga, with a population of 6,000, Pangani (3,500), Bagamoyo (5,000), Dar-es-Salaam (24,000), the seat of the Government, Kilwa (5,000), and Lindi (4,000). The most important inland town is Tabora, which has a population of 37,000 and is situated at the

junction of the main caravan routes from the coast to Tanganyika, and from Victoria Nyanza to Nyasa. Other important inland towns are Korogwe, in the Usambara Mountains, and Morogoro, Kilosa, Mpapua, and Dodoma on the road from Dar-es-Salaam to Tanganyika. On the great lakes the chief towns or settlements are Shirati, Muansa, and Bukoba on Victoria Nyanza, Ujiji, Usumbura, and Bismarckburg on Tanganyika, and Old Langenburg and Wiedhafen on Nyasa.

For administrative purposes the Protectorate is divided into twenty-four districts, as follows (the figures in parenthesis show the native population on March 31, 1913, those in italics being the density per square kilometre). Along the coast from north to south are Tanga (108,400, *23·5*), Pangani (98,500, *7·1*), Bagamoyo (72,800, *4·6*), Dar-es-Salaam (161,500, *15·1*), Rufiji (89,100, *10·0*), Kilwa (93,000, *1·6*) and Lindi (395,500, *8·3*). Along the frontier from the south-west to north-west are Ssongea (90,300, *1·6*), Langenburg (195,800, *6·5*), Bismarckburg (81,700, *0·9*), Ujiji (240,000, *6·2*), Urundi (1,500,000, *51·0*), and Ruanda (2,000,000, *72·0*). Along the frontier from the north-west to north-east are Bukoba (270,500, *10·0*), Muansa (620,000, *9·1*), Aruscha (84,200, *2·4*), Moschi (118,300, *9·2*), and Wilhelmstal (98,600, *6·3*). In the interior, roughly from north to south are Tabora (437,500, *4·1*), Kondoa-Irangi (218,300, *3·9*), Dodoma (299,400, *4·0*), Morogoro (158,400, *4·6*), Iringa (90,000, *1·3*) and Mahenge (120,000, *3·5*). The total native population in the Protectorate on March 31, 1913, was about 7,600,000 and the total white population 5,336, of which 4,107 were of German nationality and 90 British.

The means of communication have been improved considerably in recent years. Good roads for foot traffic exist between the sea-ports and the trading stations on the great lakes. Two railways are open for traffic. The Usambara railway from Tanga, on the coast, to Moschi, at the foot of Kilimanjaro, is complete and has a length of 219 miles. The Tanganyika or Central railway from Dar-es-Salaam to Kigoma on the lake has a total length of 777 miles. Other railways, either under construction or contemplated, are indicated on the map.

The foreign trade of the Protectorate follows either the overland or the coast routes. Of the former the most important is viâ the Victoria Nyanza ports and the Uganda railway. Another overland route is via Moschi and Taveta and the Uganda railway, but this has decreased in importance since the opening of the Usambara railway. In the south there is an outlet viâ the Shire river and by rail to Chinde, but the trade along this route is of small importance. The principal ports on the coast have already been referred to.

Climate

The temperature prevailing in German East Africa naturally varies considerably according to the altitude, proximity to the sea, etc. In the coastal plain the mean annual temperature according to Knox (*The Climate of the Continent of Africa*) varies between 77° and 82° F. At Dar-es-Salaam, for instance, it is 77·6° F., the highest and lowest temperatures recorded over a period of five years being 91·8° F. and 62·2° F. respectively. Along the coastal range the mean annual temperature is about 64·5° to 70° F., the maximum and minimum being 97° and 41° F. respectively. In the Usambara district the mean annual temperature varies from 61·3° F. at Kwai (5,280 ft.) to 73·4° F. at Mazindi (1,870 ft.), the absolute maximum in each case being 87·1° F. and 99·9° F., and the absolute minimum 41·9° F. and 56·3° F. respectively. Of stations in the interior, Ulanga, to the north-east of Nyasa, at an altitude of 754 ft., has extremes of 93·2° F. and 57·2° F., the daily variation in winter being 27° F. At Tosamaganga, near Iringa (5,578 ft.), the extremes for the year are 87·2° and 43·2° F., the mean daily variation being 19·3° F. At Peramiho and Ngombe, in Ssongea (4,265 ft.), the mean temperature in the warmest month is 75·4° F., and that in the coolest month 61·3° F. At Tabora (4,035 ft.) the extremes are 96·9° F. and 50·7° F. At Muansa (3,723 ft.), on Victoria Nyanza, the mean maximum temperature throughout the year is 81·6° F., and the mean minimum 61·0° F.

In common with other regions in Africa near the Equator, German East Africa possesses two dry and two

rainy seasons, one in each case being longer and more thoroughly defined than the other; the chief wet season lasts from the end of February to the end of May, and the long dry season from June to October. There is a short rainy season at the end of the year, and a short dry one at the beginning. As may be expected, the broad distribution thus indicated shows exceptions in regard to different years and in different parts of the country. The year 1910 forms an example in which the long and short wet seasons both failed to bring a rainfall equal to the average; except, in the former season, in the mountainous north-east (Kilimanjaro and Usambara) and south-west (New Langenburg, especially Muaja); in the dry seasons, too, the precipitation was below the average for those times. A contrast to the conditions of 1910 is afforded by 1911, when the rainfall in the short dry season at the beginning of the year was almost as productive as the precipitation in the chief wet season of 1910 already mentioned; the long dry season of 1911, too, gave comparatively heavy rainfalls in the north-east (especially in Moschi, West Usambara, and the hinterland of Dar-es-Salaam) and the south-west (Kondeland). This statement of conditions of more than average rainfall in the mountainous districts of the north-east and south-west may cause it to be supposed that the precipitation is always large in places lying in these regions; but this is not justified in fact, for during 1912—a year when over large areas there was the greatest precipitation since measurements began to be made—both in the north-east (particularly West Kilimanjaro and Usambara) and the south-west (mainly Ssongea and the Konde Mountains), a precipitation below, sometimes considerably below, the average was experienced. Although there was this plentiful rainfall in 1912, the distribution was very unfavourable.

It is of some general interest that the meteorological observations of 1911 and 1912 give indication respectively that a quick coming in of the north-east monsoon is followed by a small precipitation in the long rainy season (March to May), and that when the monsoon comes in gradually the rainfall of the chief wet season is comparatively great.

An indication of the quantitative nature of the rainfall is

given in the following table, which presents the details of the three highest and the three lowest precipitations in 1911 and 1912:

Period.	Number of stations.	Three highest precipitations. Inches.	Name of station.	Three lowest precipitations. Inches.	Name of station.
1911	68	156·1 [1]	Muaja	16·0 [2]	Madibira
		99·0 [1]	Bukoba	16·9 [2]	Friedenstal-Pare
		96·9 [1]	Manyangu	20·0 [2]	Kondoa-Irangi
1912	70	120·6 [1]	Manyangu	21·6 [1]	Kondoa-Irangi
		98·5 [1]	Bukoba	23·6 [1]	Ngorongoro
		96·1 [1]	Shigatini	24·8 [2]	Peramiho

[1] *Higher than the average for the station.*
[2] *Lower than the average for the station.*

The information regarding earthquakes shows that the districts where these are most frequent are Usambara in the north-west and the Livingstone Mountains in the south-west. Since systematic observations have been made, the chief activity in the former district was in 1911, and in the latter in 1909; the number of days on which earthquakes were registered were 15 and 26 respectively. No damage was done.

Mineral Resources

1. *Salient Geological Features*

Topographically and geologically, German East Africa has much in common with other parts of Eastern Africa. It is bounded seaward by a low-lying coastal plain, which is occupied largely at the surface by Tertiary and Mesozoic strata and covered in places by alluvium. This coastal plain is comparatively narrow in the northern portion of the Protectorate, where it is continuous with that of the British East Africa Protectorate; but to the south of Bagamoyo it widens out considerably.

The Tertiary, Cretaceous, and Jurassic strata of the coastal plain do not appear to have hitherto yielded minerals of any considerable commercial value. They include beds of limestone, marl, and clay which will doubtless be found of value for local use in the manufacture of mortar and cement. In this connection, also, the septaria that are reported to occur at various horizons in the Jurassic clays may prove to be of value for local use; and there appears

to be an abundance of clays that can be used for brick-making.

As regards other occurrences of economic value that may possibly be found among the rocks of this coastal belt, it is perhaps worthy of note that phosphate deposits of great commercial value occur and are mined at Safâga on the Red Sea coast of Egypt, where they occur as beds in Upper Cretaceous limestone. Petroleum also occurs at certain localities in the strata of the coastal belt of East Africa; and in British East Africa beds of manganese ore occur.

The region west of the coastal plain forms part of the great central plateau highlands of Africa, which are made up largely of ancient metamorphic rocks—gneisses and schists. Cutting the gneisses and schists, however, there are extensive intrusions of granite, with which are associated pegmatites and more basic intrusions of the diorite and diabase types. It is to these various intrusions that the more important of the economic mineral deposits of the Protectorate appear to owe their origin. Gold, mica, radio-active minerals, gem minerals, and various other features of economic interest deserve exploration in this upland region of German East Africa, which is limited on the north by Victoria Nyanza, on the south by the area around the northern portion of Lake Nyasa, on the east by the coastal plain, and on the west by Lake Tanganyika.

Overlying the ancient gneisses and schists in various parts of the upland plateau, and occupying trough-fault depressions in them, are Karoo strata (Permo-Triassic), which are coal-bearing in some localities. The older rocks of the plateau highlands also underlie the Jurassic and younger strata of the coastal belt, and indeed outcrop extensively in certain portions of the coastal districts.

The difference in level between the coastal belt and the plateau highlands is regarded as due to extensive faults that run for the most part in a roughly north and south direction, and play such an important part in the tectonic features of the whole of Eastern Africa. These faults are responsible for the extensive rift depressions

or "sunk-lands" ("Graben" of German authors) which dissect the upland plateau and in certain of which the great lakes and the soda lakes occur.

Coal-bearing Karoo strata occur in the area surrounding the northern portion of Lake Nyasa. Moreover, the shales occurring in these Karoo strata are perhaps worth investigating to see if oil-shales occur amongst them.

In the Rift valley region, on and about the northern boundary of the Protectorate to the east of Victoria Nyanza, there is a considerable area occupied by volcanic rocks, including various alkali types, mostly rich in soda. Lake Natron, which is on the German side of the boundary, is one of the soda lakes that occupy portions of the Rift valley region. Like Lake Magadi, which is on the British side of the boundary, Lake Natron is rich in trona (sodium carbonate), which separates out from the waters of the lake in the form of a crystalline crust. Leucite-bearing rocks occur among the volcanic rocks of this area, and may be worth investigating as a commercial source of potash.

Volcanic rocks also cover the surface very extensively in the region to the north of Lake Nyasa.

2. *The Chief Economic Minerals*

The chief economic minerals of German East Africa are mica, gold, garnet, coal, iron ore, uranium minerals, copal, trona, and salt. All these exist in such quantity that they are either already worked or will prove worthy of consideration under suitable conditions as regards transport facilities. Mica, gold, and garnet are exported almost wholly to Germany; whilst most of the copal is exported to Zanzibar and England.

Mica.—Mica of the muscovite variety occurs in pegmatite veins that traverse gneiss in various parts of the Protectorate. An occurrence is reported in the Ssuwi stream which drains the northern slopes of the Pongwe Mountains in the Bagamoyo district. Other localities for mica are Mkondami in the Nguru Mountains, Tangiro and Mount Fissage in the Mahenge district, and the Uluguru Mountains in the Morogoro district. Still other

localities worth mentioning as showing the widespread distribution of pegmatite mica in the Protectorate are Mombo in the Usambara district, the Woto plateau in the Langenberg district, and Mawa and Muera in the Lindi hinterland.

Of these various occurrences, the most important are those at various places in the Uluguru Mountains (Morogoro district), and it is these that are chiefly mined. The predominant rock in these mountains is a biotite gneiss. The gneiss is cut by numerous veins of pegmatite, which dip vertically or at angles slightly inclined to the vertical, and which vary in thickness up to 70 ft. or so. The mica is of the muscovite variety; it is typically of a greenish or greenish-brown colour and is highly transparent in thin plates.

The chief mica-mining localities of the Uluguru Mountains are those on the Mbakana river in the southern part of the range, and those to the north of Morogoro at the northern end of the range.

On the Mbakana there is at one locality a mica-bearing zone of pegmatite some 90 ft. in length, with a maximum width of 8 ft. at the surface. At a depth of 16 ft. the width increased to over 15 ft. Mica has been found here in sheets measuring about a square yard in area; and plates, quite free from flaws, measuring up to about $1 \times 1\frac{1}{2}$ ft. have been obtained.

Associated with the mica in these Uluguru pegmatites are the minerals uraninite (pitchblende), rutherfordine, samarskite, galena, zinc blende, bismuthinite, copper pyrites, iron pyrites, arsenopyrite, garnet, and tourmaline.

The mica of German East Africa is highly valued for use in electrical insulation, for which purpose it is as good as ordinary Indian muscovite and Canadian amber mica, though it is substantially inferior to the best Indian ruby mica.

The total amount of mica exported from German East Africa during 1912 is given as 153,806 kilograms, valued at 481,507 marks, an increase of 55,507 kilograms and 133,221 marks as compared with the output for 1911. Except 560 kilograms which was exported to Zanzibar,

the whole of the mica exported during 1912 was sent to Germany.

Gold.—Gold occurs in the stream deposits of many parts of German East Africa, both in those flowing into the Indian Ocean and in those flowing into the Victoria Nyanza. Alluvial gold deposits have been found in the Muansa district, on the south side of the Victoria Nyanza, and on the Iramba plateau, some 160 miles south-east of Muansa.

The Iramba plateau consists chiefly of granite, but partly of schists, and these rocks are traversed by dykes and veins of diorite and pegmatite. At some localities there occur numerous quartz veins that carry gold. These gold-bearing quartz veins are usually small and variable in character. At and near the surface the deposits are fairly rich in gold, but this is due to surface enrichment, and they are found to become much impoverished at even shallow depths. Samples of gold-bearing quartz at a depth of from 10 to 20 metres were found to contain 129 oz. of gold per ton; whereas samples of the sulphide ores from a depth of from 30 to 40 metres were found to contain not more than a few pennyweights per ton.

Gold deposits closely resembling those of the Iramba plateau occur in the Ikoma goldfield, some 60 miles east of Speke Gulf (Victoria Nyanza). This area is occupied by gneiss and hornblende schists, the gneiss being predominant. The hornblende schists are traversed by gold-bearing quartz veins. Some of these veins are small, and recall the Iramba type; others are of more considerable dimensions.

Near the village of Sargidi, a short distance north of Ikoma, and near Nassa, on the south-east of Victoria Nyanza, gold-bearing quartz veins of the Iramba plateau type have been found.

At Ussongo, in the northern part of the Tabora District, a porous ferruginous breccia containing about 1 oz. of gold per ton has been observed; and at Ssamuje, to the north of Ussongo, there occur itabirites and mica schists which are traversed by gold-bearing quartz veins.

Gold has also been found in alluvial deposits near the

head-waters of the river Umbekuru, which flows into the Indian Ocean and separates the Kilwa and Lindi districts in the south of the Protectorate.

The output of gold in German East Africa during 1912 is given as 234 kilograms, valued at 531,000 marks, compared with 450 kilograms, valued at 1,023,000 marks in 1911. This gold was obtained chiefly from the Kironda mine near Sekenke, in the Iramba plateau area, where veins of gold-bearing quartz occur in association with intrusions of diorite and quartz-diorite. The output of the Kironda mine was valued at 980,000 marks in 1911 and 463,000 marks in 1912. The remainder of the output was obtained mainly from a mine in the Ngasamo district (Kassama), near Speke Gulf, on Victoria Nyanza.

The ore worked at Kironda is gold-bearing quartz. Stamp mills are in use, and the gold is presumably won chiefly by amalgamation in connection with these mills, though some of it is also obtained by cyanide treatment. The average yield of gold per ton of ore mined at the Kironda mine since 1909 has been as follows:

	Grams per ton.		*Grams per ton.*
1909	38·90	1911	45·92
1910	46·45	1912	29·29

Garnet.—Almandine garnets of value as gemstones occur in hornblende gneiss at Namaputa in the Lindi district, a little to the north of the Rovuma river, in the south-eastern portion of the Protectorate. The part of the country in which these garnetiferous gneisses occur is better known as the Luisenfelde. The hornblende gneiss is much weathered at the surface, and is consequently friable. The garnets are easily obtained from the surface rock, and they are also found loose at the surface. They are described as having a fiery columbine-red colour. They are stated to have occurred abundantly as specimens of good quality, and to have been well received on the market. Rough stones of the better class have been sold at 200 marks per kilogram. Recently, however, garnet mining seems to have been almost at a standstill. The total amount of gem garnet exported during 1912 is given as 8 kilograms, valued at 600 marks, as compared with

154 kilograms, valued at 11,811 marks, exported in 1911. The garnet was all exported to Germany.

Coal.—As already mentioned, Karoo strata occur in various parts of the plateau highlands, notably in the area surrounding the northern portion of Lake Nyasa; and these strata contain coal beds. Many of these beds are thin, and consist of coal of poor quality, as, for example, those near the mouth of the Ruhuhu on the east side of Lake Nyasa. On the other side of the lake, in the British Protectorate of Nyasaland, and opposite the Ruhuhu, are the coal-bearing Karoo beds of Mount Waller.

More important than these Ruhuhu deposits, however, are those in the Karoo beds to the north-west of the lake, on the Songwe (Songue) and Kivira rivers. In this area, a section in the Kandete stream shows a thickness of 11 metres of coal in a total thickness of 20·7 metres. One portion of this section shows a seam of coal 4·90 metres thick with two thin shale partings, which together have a thickness of only 6 centimetres.

The average composition of the coal of this 4·9 metres seam is as follows: Carbon 60·60, hydrogen 3·00, oxygen 13·00, sulphur 0·25, moisture 4·33, ash 18·50 per cent.; the yield of coke was 78·70 per cent., and the calorific value 5,657 calories. Certain of the seams show a higher percentage of carbon, up to 70 per cent., and a calorific value of 6,840 calories. The ash in some samples falls as low as 5 per cent. The coal is of the bituminous type, and is of considerable value as fuel, and on account of its coking property could be used also for smelting iron ore.

Coal is, moreover, known to occur on the western shore of Tanganyika, in the Congo territory; and as Karoo strata occur at various places on the German East Africa side of the lake, it is not improbable that coal occurs in these strata.

Iron Ore.—Iron ore of the lateritic type occurs at the surface in various parts of German East Africa, and is smelted in a primitive way by natives at Ku Ndapa in the Livingstone Mountains, north-east of Lake Nyasa.

In the Upangua district, at the southern end of the Livingstone range, and near Lake Nyasa, hæmatite ore occurs. A sample of this gave ferric oxide, Fe_2O_3, 75·75, and insoluble residue 22·88 per cent., titanium being absent. In the same region, and some miles to the south of the Ruhuhu, in the Mtambalala stream, spathic iron ore occurs, a sample of which gave ferrous oxide, FeO, 47·95; lime, CaO, 1·24; magnesia, MgO, 0·60; alumina, Al_2O_3, 1·57; carbon dioxide, CO_2, 27·04; phosphoric oxide, P_2O_5, 0·50; water, H_2O, 3·34; and insoluble residue 18·20 per cent.

More important than these perhaps are the magnetic iron ores (some of which are titaniferous, however), that occur in thick bands in the gneisses at various localities. Notable among these are the occurrences in the Uluguru range. On the western side of this range, at Hundussi, magnetite occurs, a sample of which gave magnetic iron oxide, Fe_3O_4, 65·52; titanium dioxide, TiO_2, 1·85; and insoluble residue 30·88 per cent. In the Mbakana stream titaniferous iron ore with as much as 25 per cent. of titanium dioxide occurs. Iron ore, including magnetite and hæmatite varieties, has also been found in some quantity at Midindo, near Mamboya.

Magnetic iron ore and limonite occur also in the Ruanda district and other places in the region between the Victoria Nyanza and the northern end of Lake Tanganyika, where they are to some extent worked by natives.

In connection with iron ores, the occurrence of itabirites (hæmatite schists) in the northern part of the Tabora district is perhaps worthy of note.

The existence of coking coal of good quality in the Protectorate (see p. 591) renders it desirable to explore more fully these iron ores with a view to the establishment of a smelting industry.

Cement Materials.—Crystalline limestones of metamorphic origin occur associated with the ancient gneisses in many parts of the Protectorate, as in the Uluguru, Livingstone, and Pongwe Mountains. These limestones, however, are frequently dolomitic (magnesian) and contain various secondary silicates, sometimes with apatite and graphite.

Ordinary limestones are abundant in the Tertiary,

Cretaceous, and Jurassic strata of the coastal belt. Some of these are argillaceous, and doubtless include natural cement stones.

Clays and shales also are abundant in the Tertiary, Cretaceous, and Jurassic rocks of the coastal districts. Septaria occur freely in the Jurassic clays at some horizons.

Uranium (Radio-active) Minerals.—Associated with muscovite in the pegmatites of the Uluguru Mountains (see p. 588) there are uranium minerals containing a high percentage of uranium and therefore of importance on account of their radio-active properties. The uranium minerals hitherto described include uraninite (pitchblende), rutherfordine, and samarskite, but further investigation is called for.

Uraninite (pitchblende).—This mineral has been found in exceptionally large crystals in the mica pegmatites of the Lukwangule hills (Mbakana area) in the Uluguru range. The uraninite is found embedded in mica in the form of cubes, octahedra, and massive lumps. A well-defined cube measuring 3·5 × 2·5 × 2 centimetres has been described, and much larger specimens showing crystalline form are found.

Masses of uraninite weighing as much as 70 lb. are stated to have been found as isolated aggregates in the pegmatite veins. The unaltered uraninite has a specific gravity about 8·8, and one specimen with a specific gravity 8·63 gave the following analysis: uranium oxide, U_3O_8, 89·47; lead oxide, PbO, 6·87; lime, CaO, 0·82; silica, SiO_2, 0·52; ferrous oxide, FeO, 0·48; thoria, ThO_2, 0·20; water, H_2O, 2·03 per cent. The uraninite specimens are frequently altered on the surface to rutherfordine, and some are completely pseudomorphosed.

It is of interest to note that the occurrence of uraninite in these mica pegmatites of German East Africa is closely paralleled by the occurrence of uraninite in the mica mines near Singar in the Gaya district of Bengal.

Rutherfordine.—This is a yellow uranium carbonate (UO_2CO_3) formed as an alteration product of the Uluguru uraninite, specimens of which are usually covered by a

yellow crust of this material. Some specimens are completely altered (pseudomorphosed) to this yellow carbonate, which has a specific gravity of 4·82. An analysis of a specimen of rutherfordine gave uranium oxide, UO_3, 83·8; carbon dioxide, CO_2, 12·1; lead oxide, PbO, 1·0; ferrous oxide, FeO, 0·8; lime, CaO, 1·1; water, H_2O, 0·7; insoluble residue, 0·8 per cent.

Samarskite.—Specimens of samarskite containing 7·5 per cent. of lead oxide, and for this reason described as a separate species under the name "plumboniobite," have been found in the mica pegmatites of the Morogoro district, in the mica mines at the northern end of the Uluguru range. A specimen with a specific gravity 4·8 gave the following analysis: niobic oxide, Nb_2O_5, 46·03; tantalic oxide, Ta_2O_5, 1·20; uranium oxide, UO_2, 13·60; titanium dioxide, TiO_2, 0·90; yttria, Y_2O_3, 14·12; ferric oxide, Fe_2O_3, 5·72; alumina, Al_2O_3, 0·17; lead oxide, PbO, 7·55; copper oxide, CuO, 1·21. The percentage of lead is higher than that usually recorded for samarskite, but is insufficient to warrant one in regarding this as a new species; it is therefore described here as a samarskite. It is worthy of note that samarskite occurs in certain mica pegmatites of Canada and India under conditions closely similar to those obtaining in the Morogoro mines of German East Africa.

Copal.—At many localities on the coastal plain and near the coast, as on the Noto, Makonde, and Muera plateaux, fossil resin of the copal variety is dug from the surface sands by natives. The pits from which it is obtained are very shallow, being dug to a depth of not more than 2 ft. The winning of copal in this way is sufficient to repay the labour of the natives, who send the copal to Lindi and other markets on the coast. The product comes on the British market via Zanzibar and is known here as Zanzibar copal.

There has been a gradual decrease in the exports of copal in recent years, except in 1912, when there was a small increase to 106 tons, worth nearly £6,000. Partly owing to the extent to which the copal-bearing alluvium has been already worked, and partly owing to the fact that there are other and more remunera-

tive fields of labour for the natives, it is not expected that this increase will be maintained.

Trona (hydrated acid sodium carbonate) occurs abundantly in the form of a white crystalline crust in Lake Natron, a large soda lake occupying a portion of the Rift valley near the northern boundary of the Protectorate, between Victoria Nyanza and Kilimanjaro. The trona deposit of Lake Natron is of the same character as that of Lake Magadi in British East Africa, which is at the present time the object of a great commercial enterprise. A sample of trona from the south-west shore of Lake Natron gave on analysis 68·5 per cent. of sodium carbonate (Na_2CO_3), and 29·5 per cent. of water (H_2O).

Salt.—The natives obtain common salt in a very primitive manner by the evaporation of sea water in shallow "salines" along the coast. More important is the Gottorp Saline in the Ujiji district near Tanganyika, from which there was during 1912 an output of 2,000 tons of salt, valued at 200,000 marks. This salt is obtained from the water of salt springs by evaporation. The spring water is of a dirty yellow colour; it smells strongly of sulphuretted hydrogen, has a specific gravity of about 1·1, and contains about 11·6 per cent. of sodium chloride.

3. *Other Minerals of Economic Interest*

Under this heading may be enumerated the various minerals of economic interest which have hitherto been found in only small quantities, usually too small to make them worth working. These may, however, be regarded as of some importance from the prospector's standpoint, since their occurrence would suggest the possibility that larger deposits may occur.

Agate (a banded variety of compact silica) is stated to occur associated with amethyst, near Gottorp in the Ujiji district.

Amethyst (a gemstone variety of quartz).—Transparent amethyst of a fairly good colour has been found at Midindo, a locality between Mamboya and Kitangi, in the eastern portion of the Dodoma District.

Amethysts are also stated to occur associated with agates near Gottorp, in the Ujiji district.

Arsenopyrite (sulphide of iron and arsenic) occurs in the auriferous quartz veins of the Ikoma district, and in the mica pegmatites of the Uluguru Mountains.

Asbestos is reported to occur at Morogoro, and the occurrence is said to be a promising one.

Beryl (silicate of beryllium and aluminium) of a pale green colour occurs associated with tourmaline and muscovite in pegmatite veins traversing gneiss at Namaputa, near the garnet locality mentioned on p. 590.

Bismuthinite (sulphide of bismuth) occurs in the mica pegmatites of the Uluguru Mountains.

Bitumen.—An occurrence of material described as bitumen has been observed at Wingayongo. It gave on analysis: carbon 20·29, hydrogen 1·75, oxygen 0·99, nitrogen 1·02, sulphur 1·89, water 1·85, and ash 72·21 per cent. The high percentage of carbon and the low percentage of hydrogen in the ash-free portion of this material would appear to indicate that it is more in the nature of coaly material than true bitumen; and the occurrence is not such as can be regarded as an indication of the presence of petroleum.

Bitumen is also reported to occur in the area at the north end of Lake Tanganyika.

Copper Pyrites (sulphide of copper and iron) occurs in the auriferous quartz veins of the Ikoma district, and associated with muscovite in the pegmatites of the eastern part of the Uluguru Mountains.

Ore-minerals of copper are stated to occur also at Massassi in the Lindi hinterland, and in the Langenburg district near the north end of Lake Nyasa, but no considerable deposit of copper ore has yet been found.

Corundum.—Crystals of reddish opaque corundum, 2 to 3 cm. in length, have been found at Mulale (Mlale), a locality in the eastern part of the Dodoma district. Associated with this corundum, and embedded in it, were small crystals of rutile.

Diamond.—A fine crystal of diamond was discovered in the coastal sands at Bagamoyo in 1911; but though this

occurrence appears to have been fully confirmed, it has not been followed by any further discoveries.

Epsomite (hydrated sulphate of magnesium) occurs in the Karoo shales outcropping in the Kokwa Mdogo stream, a tributary of the Rufiya river.

Felspar.—The orthoclase variety of felspar (silicate of potassium and aluminium) occurs abundantly in the mica-bearing pegmatites of the gneissic areas.

Galena (lead sulphide) occurs in the auriferous quartz veins of the Ikoma district and in the mica pegmatites of the Uluguru Mountains. Lead ores are stated to occur at Kondoa Irangi, but hitherto no workable deposits have been found.

Garnet of the almandine gemstone variety (silicate of iron and aluminium) has already been referred to as occurring at Namaputa. In addition to this it occurs abundantly in other gneissic areas, as in the Usambara district and the Uluguru mountains, in the coarser variety that is sometimes used for abrasive purposes.

Graphite (a crystalline variety of carbon) occurs in some abundance disseminated through gneiss in various parts of the Protectorate, notably in the central and eastern parts of the Uluguru Mountains, and in the Lindi hinterland. These graphitic gneisses are abundant in other parts of east-central Africa, and in certain places, as in Nyasaland, there occur lenticular masses of exceptionally good quality, though of limited extent. Lenticular masses of graphite occur in the gneisses of the Lindi hinterland, but no deposits that are workable under existing conditions have yet been found in German East Africa.

Gypsum (hydrated calcium sulphate) occurs in the Jurassic strata of the coastal plain. It is seen in outcrops in the Mahakonde stream in the Kilwa district, and it occurs also further north in Ukhwere.

Iron Pyrites (iron disulphide) occurs in the gold-bearing quartz veins of the Ikoma district; also in the mica pegmatites of the Uluguru Mountains, and at various other localities. Cupriferous pyrites occurs in quartz veins near Ubena, in the southern part of the Iringa district.

Kaolin (hydrated silicate of aluminium).—Pure white china clay, resulting from the alteration of orthoclase felspar, has been found at Ikwamba, between Uponera and Kisitwi in the eastern portion of the Dodoma district. Kaolin occurs also in the Karagwe district not far from Buboba, to the west of Victoria Nyanza.

Leucite (silicate of potassium and aluminium).—This mineral, which has been used elsewhere to some extent as a source of potash salts, occurs as a constituent of certain of the alkali volcanic rocks in the northern portion of the Protectorate, notably around Niragongo in the area to the north-east of Lake Kivu, Ruanda district.

Lignite or Brown Coal occurs in clay beds that outcrop in the Makebe stream in the hinterland of Mtshinga. An analysis of this brown coal gave carbon 54·70, hydrogen 3·05, oxygen 21·78, sulphur 0·01, moisture 16·26, and ash 4·20 per cent. The yield of coke was 46·15 per cent., and the calorific value 5,030 calories. The lignite seen in the Makebe stream does not form continuous beds, but occurs in the form of isolated lumps and broken layers. Associated with the brown coal in these Makebe clay beds are lumps of yellow ochre and earthy sulphur which appear to have resulted from the decomposition of pyrites.

Manganese Ore occurs in the Unata district some 25 kilometres W.N.W. of Ikoma; and psilomelane has been found in the Kipengele hills, in Livingstone Mountains.

Monazite (phosphate of cerium and other rare earths, with a variable percentage of thoria).—This mineral is known to occur in other parts of East Africa, and it is probable that it occurs also in German East Africa (see tin ore, p. 599).

Phenacite (beryllium silicate).—A crystal of perfectly colourless and transparent phenacite of gem quality, 1½ cm. long and nearly 1 cm. wide, has been found in the Kisitwi Mountains, which lie to the east of Mpapua (Mpapwa) in the eastern portion of the Dodoma district. The rocks of these mountains consist of biotite gneiss and garnetiferous hornblende gneiss, which gneisses are not improbably traversed by pegmatite veins.

Silver Ore is said to occur near Ujiji on the east side

of Tanganyika; and also in the area west of Victoria Nyanza, near the northern boundary of the Protectorate.

Sulphur.—The sandstones of Wingayongo are impregnated with sulphur, crystals of which occur in the cavities of the rock. The amount of sulphur present in the sandstone is stated to be too low to make the rock workable as a source of sulphur.

Tin Ore.—No tin ore has been found up to the present, but it has been suggested that both tinstone and monazite may be expected to occur in association with the granitic intrusions which have such an extensive distribution on the upland plateau.

Tourmaline (a complex boro-silicate of aluminium, iron, magnesium, and other elements) occurs in the pegmatites of Namaputa near the garnet locality, and in the mica pegmatites of the Uluguru Mountains. It occurs also in good crystals in the Kisitwi mountains, and doubtless in many other localities, but the specimens hitherto found have been of the black variety, opaque in the mass, and of no value as a gemstone.

Zinc Blende (zinc sulphide) occurs in the mica pegmatites of the Uluguru Mountains.

From this brief account of our knowledge of the minerals of German East Africa and of the geological conditions under which they occur, it is evident that the country is highly mineralised, and that its further commercial development from this point of view only awaits more detailed systematic prospecting such as has been carried on under the auspices of the Imperial Institute in other countries.

In a succeeding article the Agricultural and Forest Resources of German East Africa will be described.

THE PRESENT SCARCITY OF THE ANTISEPTIC THYMOL

Hitherto almost the sole source of commercial thymol has been ajowan oil derived from ajowan seeds (*Carum copticum*, Benth.). Prior to the war practically the whole

of the exports of ajowan seeds from India went to Germany, where the thymol was prepared. Owing to the cessation of trade between this country and Germany there has been a great scarcity of thymol in the United Kingdom, and the price has increased greatly. Up to the end of July the price had risen considerably owing to a deficiency in the supply of ajowan seed, and since then it has reached as much as 40*s*. per lb. The fluctuation in price since April last is shown in the following table:

	Per lb.		Per lb.
April 16	6*s*. 8*d*.–6*s*. 9*d*.	August 20	25*s*.
May 21	6*s*. 6*d*.–6*s*. 9*d*.	September 3	30*s*.
June 4	7*s*. 6*d*.	September 17	40*s*.
July 2	7*s*. 9*d*.	October 1	25*s*.–30*s*.
July 16	9*s*.–9*s*. 3*d*.	November 5	25*s*.
July 30	14*s*.–14*s*. 6*d*.	December 21	21*s*. 6*d*.

The manufacture of thymol is a simple process, and there is no reason why it should not be carried on in this country. At the same time the possibility of obtaining thymol from other sources is worth consideration, as well as the possibility of employing the isomeric phenol, carvacrol, in place of thymol for antiseptic purposes.

Preparation of Thymol

The distillation of the volatile oil from ajowan seed can be readily carried out by the ordinary method in which the seeds, previously crushed or comminuted, are placed in a wire basket or on a false bottom in a still in which steam is either generated or received from a separate boiler. The quantity of oil in the seed is about 3 to 4 per cent., and the oil usually contains from 40 to 55 per cent. of thymol.

For the preparation of thymol the oil should be freshly distilled, pale coloured and clean. It is shaken thoroughly with a warm aqueous solution of caustic soda, which dissolves out the thymol, the latter remaining in the aqueous layer when this separates from the residue of the oil. The aqueous layer is collected by means of any ordinary form of separator, or separating funnel, and the treatment repeated on the residual oil until the latter is free from

thymol. The combined warm aqueous liquids are then set aside to clear completely, and when quite clear they are acidified by the addition of excess of hydrochloric acid, when the thymol rises to the surface as an oily layer. The acid aqueous liquid is run off and replaced by clean warm water, which is shaken up thoroughly with the thymol to remove all traces of acid. The washing water is then run off completely, and the warm liquid thymol run into a dish and a crystal of thymol added. The mass then usually solidifies, and merely requires pressing free from liquid to yield crystalline thymol.

The residual oil, which amounts to about 50 per cent. of the original oil, allowing for loss in manufacture, is generally sold as a cheap perfume for soap-making and similar purposes under the name "thymene."

New Sources of Thymol

In addition to ajowan seeds there are a number of plants which yield oils containing thymol, the more important of which are dealt with below.

Cunila mariana, L.—This plant, which yields oil of dittany, is native to North America. The dry herb yields 0·7 per cent. of oil containing about 40 per cent. of a phenol which has been stated to consist of thymol.

Monarda punctata, L. (American horsemint).—This yields from 1 to 3 per cent. of oil containing 61 per cent. of thymol. According to *Schimmel & Co.'s Report* (Oct. 1885, p. 20), the oil at one time was used for the preparation of thymol on a large scale.

Mosla japonica, Maxim.—The dry herb of this plant, which is indigenous to Japan, yields 2·13 per cent. of oil containing 44 per cent. of thymol.

Ocimum gratissimum, L.—This West African plant yields an oil which is stated to contain 44 per cent. of phenolic constituents, consisting almost entirely of thymol (cf. this BULLETIN, 1913, **11**, 131).

Ocimum viride, Willd.—Several samples of this plant, which is known in West Africa and the West Indies as the "mosquito plant," owing to its alleged property of keeping off

these insects, have been examined at the Imperial Institute. A sample of the dried leaves from the Northern Provinces of Nigeria yielded 1·2 per cent. of oil, while three samples from Sierra Leone yielded 0·35, 0·86, and 0·89 per cent. of oil respectively. The oil in the latter cases was found to contain 32, 55, and 65 per cent. of thymol. A sample of the oil distilled in Sierra Leone has also been examined, and this was found to yield 58 per cent. of thymol.

Origanum floribundum, Munb.—Native to North Africa, and yields an oil containing about 25 per cent. of thymol.

Origanum hirtum, Link.—Specimens of this plant collected in Dalmatia have been examined at the Imperial Institute. The dry herb yielded 3·3 per cent. of oil containing 66–67 per cent. of thymol (this BULLETIN, 1911, **9**, 388). Oils distilled from plants grown in the Adriatic islands of Curzola and Lissa have been stated to yield 51 to 60 per cent. of thymol.

Satureia Thymbra, L.—According to *Schimmel & Co.'s Report* for October 1889, p. 55, this plant yields an oil containing about 19 per cent. of thymol.

Thymus vulgaris, L.—The phenol content of thyme oil varies as a rule from 20 to 25 per cent., but in rare cases rises to 42 per cent. The character of the phenol varies; as a rule in French and German oils it consists mainly of thymol, but under certain conditions the latter may be replaced by carvacrol. The yield of oil from the dried German herb is 1·7 per cent. and from the dried French herb 2·5 to 2·6 per cent.

Of the plants referred to above, *Ocimum viride*, *Monarda punctata*, *Origanum hirtum*, and *Thymus vulgaris* appear to be the most promising as sources of thymol. *Ocimum viride* is stated to occur wild on all soils in every part of Sierra Leone, and a few plants are cultivated in nearly every yard in the Colony on account of its medicinal properties. The plant also occurs in other parts of West Africa and in the West Indies. It can be easily raised from seed, and its cultivation might prove profitable under present conditions. *Monarda punctata* occurs in parts of Canada and the United States, and it should be possible to obtain supplies of the herb. *Origanum hirtum*, on the

other hand, occurs in the Eastern Mediterranean region, and in view of the disturbed state of that area it is doubtful whether the plant could be collected in sufficient quantities at the present time.

Thyme oil, from *Thymus vulgaris*, is of course an article of commerce, and judging from the price of the French oil on the market there is so far no scarcity in the supplies; the price in London on October 20 was the same as that on January 19, viz. 5*s*. per lb. With thymol at its present high price it would pay to prepare it from thyme oil, but not under normal conditions.

Carvacrol as a Substitute for Thymol

Carvacrol is a phenol isomeric with thymol, and this fact alone suggests that it might be of value for antiseptic purposes. When freshly distilled, carvacrol is a colourless, viscid oil which becomes yellowish in the course of time. It has melting point + 0·5° to + 1° C., boiling point 236° to 237° C. (corrected), and specific gravity at 15° C. 0·981. Carvacrol is the chief constituent of the oils derived from a number of plants belonging to the N.O. Labiatæ, the most important being the following:

Monarda fistulosa, L. (wild bergamot).—This oil contains 52 to 58 per cent. of carvacrol.

Origanum dubium, Boiss. (Cyprus origanum).—This oil has been investigated at the Imperial Institute and found to contain 82·5 per cent. (by volume) of carvacrol (this BULLETIN, 1906, **4**, 296; 1908, **6**, 208). Trieste or Cretan origanum oil also consists principally of carvacrol, but the botanical origin of the plant yielding this oil seems to be doubtful. It is sometimes said to be *O. hirtum*, Link, but a sample of the latter herb, examined at the Imperial Institute, contained thymol, not carvacrol (see p. 602).

Origanum Onites, L. (= *O. Smyrnaeum*, L.).—This plant yields Smyrna origanum oil. A specimen of the herb has been examined at the Imperial Institute and yielded an oil containing 68 per cent. (by volume) of phenols, consisting almost wholly of carvacrol (this BULLETIN, 1911, **9**, 388).

Satureia hortensis, L.—The oil contains 38 to 42 per cent. of carvacrol.

Satureia montana, L. (white thyme).—The oil distilled from wild plants of this species contains 35 to 40 per cent. of carvacrol, but that from cultivated plants has been found to contain as much as 65 per cent. A sample of Dalmatian white thyme, identified at the Royal Botanic Gardens, Kew, as a form of *S. montana*, L., has been examined at the Imperial Institute. It yielded an oil containing 68·75 per cent. of phenolic constituents consisting mostly of carvacrol (*loc. cit.*).

Thymus vulgaris, L. (thyme).—As already mentioned thyme oil sometimes contains carvacrol in place of thymol (see p. 602).

Of these oils Cyprus origanum oil is the most promising as a source of carvacrol at the present time; most of the others not only contain less but are produced in regions which are greatly affected by the war. The Cyprus oil is already produced in commercial quantities, 42 cwts., valued at £980, being exported to the United Kingdom in 1913. So far the oil has been obtained solely from wild plants. It has been suggested, however, that the plant could probably be cultivated profitably, and it has been stated that experiments to determine this point were to be carried out by the Agricultural Department in 1913, but the results have so far not been published.

The chief use for thymol is the preparation of various antiseptic toilet preparations, but it has also been employed in recent years in the treatment of ankylostomiasis, certain skin diseases, etc. So far as can be ascertained, carvacrol has not hitherto been employed in medicine, but the antiseptic properties of origanum oil, consisting principally of carvacrol, as well as of the phenol itself, have been investigated by several workers. Chamberland (*Ann. de l'Inst. Pasteur*, 1887, **1**, 153), in a series of experiments with various essential oils, showed that a saponaceous solution of origanum oil containing 1 part of oil in 24,200 parts of solution inhibited the growth of the anthrax bacillus, and that the oil had practically the same antiseptic power as copper sulphate. Experiments carried out by

Cadeac and Meunier (*loc. cit.* 1889) also demonstrated the powerful bactericidal action of origanum oil.

The value of carvacrol as an antiseptic has been investigated by Dr. W. Harrison Martindale (*Perf. and Ess. Oil Record*, 1910, **1**, 266), who found that in its action on *Bacillus coli communis* it had a carbolic acid coefficient of 21·32 as compared with 25·29 in the case of thymol, whilst origanum oil, containing 82 per cent. of carvacrol, had a coefficient of 25·76. This means that by the test employed origanum oil and carvacrol were 25·76 and 21·32 times, respectively, as strong an antiseptic as pure carbolic acid. As an outcome of Dr. Martindale's experiments saponaceous solutions of origanum and other oils have been prepared for physicians' use under the name "Perfumed Formosyls." Iodide of carvacrol ("iodocrol"), a reddish-brown powder, has been used as an antiseptic. It is said to possess the advantage over iodoform of being odourless and 5 times the strength in bactericidal power, whilst it is more bulky and therefore of greater value for dusting purposes. Iodocrol has also been used in surgical dressings in the treatment of eczema, chancre, and other diseases.

GENERAL NOTES

Report on the Work of the Imperial Institute, 1913.—A summary of the work carried out at the Imperial Institute for the Dominions, Colonies, and Dependencies during 1913 has now been issued in the *Annual Series of Colonial Reports*, No. 816 [Cd. 7622–7].

Mineral Survey of the Southern Provinces, Nigeria.—The Report on the results of the work conducted in connection with the Imperial Institute by the Mineral Survey of the Southern Provinces, Nigeria, during 1913 has recently been published in the *Miscellaneous Series of Colonial Reports*, No. 89 [Cd. 7567]. In that year the work of the Survey was devoted to exploring the western boundary of the Udi-Okwoga coalfield and to ascertaining the shortest distance of a workable seam from Onitsha or Idah. Several boreholes were put down near Onitsha, and seams of coal were met with at two places. Surface prospecting was also carried on, and coal seams were found in the Idah district and in the west of the Udi coal

district. The western boundary of the coalfield was defined, and it was found that the coal measures gradually increased in width from about 10 miles in the extreme south to about 40 miles in the north.

The Report also includes the results of examination at the Imperial Institute of mineral specimens collected by the surveyors during the year. Several samples of coal were examined, as well as samples of lignite, clay, iron ore, and limestone, and specimens of rocks and other material from various boreholes.

Proceedings of the Third International Congress of Tropical Agriculture.—Reference has already been made in this BULLETIN to the Third International Congress of Tropical Agriculture, which was held at the Imperial Institute in June 1914. The *Proceedings* of the Congress have now been published by Messrs. John Bale, Sons & Danielsson, Great Titchfield Street, Oxford Street, London, W., and copies can be obtained from booksellers or from the publishers at 10*s*., or 10*s*. 4*d*. post free in the United Kingdom, abroad, 10*s*. 8*d*.

The *Proceedings* occupy 407 octavo pages, and contain the address delivered by the President of the Congress, Professor Wyndham Dunstan, C.M.G., LL.D., F.R.S., Director of the Imperial Institute and President of the International Association for Tropical Agriculture. Abstracts of all the more important papers read at the Congress are also printed, as well as a full report of the various important discussions which took place.

The subjects discussed at the Congress included: Technical Education in Tropical Agriculture; Sanitation and Hygiene on Tropical Estates; Legislation against Plant Diseases and Pests; Agricultural Credit Banks and Co-operative Societies; The Organisation of Agricultural Departments in relation to Research; The Fertility of Soils; The Properties of Plantation Para Rubber, with Special Reference to its Uses for Manufacturing Purposes; and The Improvement of Cotton Cultivation. In addition papers were read and discussed on rubber, cereals, sugar, cocoa, tobacco, jute and hemp fibres, cotton, and other tropical products.

Among the speakers in these discussions were the Right Hon. Lewis Harcourt, M.P., Secretary of State for the Colonies, Earl Kitchener, Earl of Derby, Lord Emmott, and well-known authorities on tropical agricultural from all parts of the world. The volume is a valuable record of authoritative opinions on the important problems of tropical agriculture and industries, which are of special interest at the present time.

Barosma venusta leaves from South Africa.—A sample of *B. venusta* leaves from South Africa was received at the

Imperial Institute for examination in February 1912. It was desired to ascertain whether the leaves could be used in medicine as a substitute for buchu leaves of commerce derived from *B. betulina*. On distillation in a current of steam the leaves yielded 2·7 per cent. of a volatile oil, which was of a lemon-yellow colour and pleasant odour, with specific gravity at 15°/15° C. 0·877, and optical rotation in a 100 mm. tube at 24° C. + 1° 4′. A larger consignment of the leaves, received in 1913, furnished 2 per cent. of volatile oil with the following constants: specific gravity at 15°/15° C. 0·865, optical rotation in a 100 mm. tube at 22° C. + 0° 47′, acid value 5·6, ester value 6·2 (corresponding with 2·2 per cent. of esters, calculated as $C_{10}H_{17} \cdot OAc$), ester value after acetylation 55 (corresponding with 15·7 per cent. of total alcohols, or 14·3 per cent. of free alcohols and 2·2 per cent. of esters).

A detailed chemical examination of this oil has been made by Dr. Ernest Goulding, F.I.C., and Mr. O. D. Roberts, A.I.C., of the Scientific and Technical Department of the Imperial Institute, and the results communicated recently to the Chemical Society of London (*Journ. Chem. Soc.*, 1914, **105**, 2613). The approximate percentage composition of the oil was found to be as follows: hydrocarbons, chiefly or entirely myrcene, 43·0; aldehydes, chiefly or entirely anisaldehyde, 0·5; phenols, 0·2; phenol ethers, methylchavicol, 21·4; alcohols, partly linalool (calculated as $C_{10}H_{17} \cdot OH$), 14·3; esters (calculated as $C_{10}H_{17} \cdot OAc$), 2·2; sesquiterpenes, loss, etc. (by difference), 18·4. Diosphenol, the most characteristic constituent of the oil of *B. betulina*, was shown to be absent.

The oil of *B. venusta* thus differs considerably from that of *B. betulina*, and the leaves of the former species cannot be used in medicine in place of the ordinary buchus of commerce.

Estimation of Prussic Acid in Feeding-Stuffs.—The value of a feeding-stuff depends not merely on the amount of nutritive material present, but also on the presence or absence of harmful ingredients. Of the latter, cyanogenetic glucosides, which on hydrolysis give rise to the formation of hydrocyanic acid (prussic acid), are of frequent occurrence (see this BULLETIN, 1903, **1**, 15, 112; 1905, **3**, 373; 1906, **4**, 334; 1912, **10**, 653). The estimation of hydrocyanic acid by the iodine or silver nitrate titration methods often presents some difficulty, especially when oils or fats are present, and a new method has been devised by Dr. J. R. Furlong, Ph.D., of the Scientific and Technical Department of the Imperial Institute (*Analyst*, 1914, **39**, 430). The method consists essentially in the conversion of the hydrocyanic acid into prussian blue and the comparison of the resulting coloration with standards. Full details regarding the method of preparing the material and the standards are given.

The paper also quotes the results of examination at the Imperial Institute of millet and guinea corn plants from the Northern Provinces, Nigeria, which have been shown to contain cyanogenetic glucosides under certain conditions (cf. this BULLETIN, 1910, **8**, 384).

The Viscosity of Rubber Solutions.—The question of the viscosity of rubber solutions is one of considerable importance in view of the suggestion that the viscosity is closely connected with the quality and technical value of the rubber. The viscosity of solutions of plantation Para, fine hard Para, Castilloa, Funtumia, and Ceara rubbers has been investigated recently in the Scientific and Technical Department of the Imperial Institute by Dr. R. Gaunt, Ph.D., and a paper giving details of the results was lately read before the Society of Chemical Industry (*Journ. Soc. Chem. Indust.*, 1914, **33**, 446). The paper deals with the solubility of rubber, viscosity of rubber in different solvents, change in viscosity of rubber solutions, the effect of concentration on the change in viscosity, change in viscosity of rubber in different solvents, and the change in viscosity of different rubbers in solution.

New Markets for Sudan Produce.—Owing to the war and the consequent cessation of trade with Germany and Austria-Hungary, a quantity of material formerly exported to those countries from the Sudan has become available for other markets. Foremost among such products is gum arabic, the total exports of which amounted to 15,129,200 kilograms, valued at £381,203, in 1913. Of this quantity 2,843,784 kilograms, of value £68,821, went to Germany direct, and 610,763 kilograms, of value £14,048, to Austria-Hungary. Among other countries to which the gum was exported were France (3,505,757 kilograms, valued at £90,618), United Kingdom (2,720,961 kilograms, valued at £70,092), and United States (2,068,820 kilograms, valued at £52,088). An account of the uses and value of Sudan gum will be found in this BULLETIN (1908, **6**, 29).

Other products available for export are sesame seed, dura, vegetable ivory nuts, sant pods, hides and skins, and ivory.

Most of the sesame hitherto exported from the Sudan has gone to Egypt, but 249,589 kilograms, valued at £3,926, went to Germany in 1913. The total exports in that year amounted to 6,841,260 kilograms, valued at £107,673. Two samples of the seed from the Sudan were examined at the Imperial Institute in 1912; they were both of good quality, and the better was valued at £17 10*s.* per ton, with large white Bombay seed at £17 17*s.* 6*d.* per ton (this BULLETIN, 1913, **11**, 56).

Dura (*Sorghum vulgare*) is the staple food grain of the country, and only the surplus produce is available for

export. The amount exported in 1913 was 2,080,071 kilograms, valued at £22,282, all of which went to Egypt and Eritrea. This year the rains have been very favourable, and it is anticipated that a considerable quantity of the grain will be available for export. Feeding trials with Sudan dura have been carried out in Austria and in this country which have shown that it is about equal in value to maize for this purpose (this BULLETIN, 1911, **9**, 253; 1913, **11**, 37), whilst technical trials have indicated that it could probably be substituted for maize in the manufacture of certain kinds of spirit.

The vegetable ivory nuts exported from the Sudan are derived from the dom or doum palm (*Hyphaene thebaica*). They are already exported to some extent to this country, but the chief markets are Italy and the United States. The total exports in 1913 amounted to 1,349,109 kilograms, valued at £8,190. For an account of the utilisation of these nuts as vegetable ivory, see this BULLETIN (1911, **9**, 105).

Sant pods, derived from *Acacia arabica*, are widely used in the Sudan for tanning purposes. The whole pods contain about 30 per cent. of tannin, and yield a leather of good quality and pale colour. A sample of the whole pods examined at the Imperial Institute recently was valued at £7 per ton, and a small experimental consignment was subsequently sold at this price (this BULLETIN, 1913, **11**, 408).

The total value of untanned hides exported from the Sudan in 1913 amounted to £23,415, of which more than half went to Austria and France in about equal proportions. Untanned skins of sheep and goats to the value of £32,737 were also exported in 1913, chiefly to the United Kingdom, Egypt, and France.

Large numbers of cattle and sheep are available for export to Egypt and the nearer markets in the Mediterranean region, and on the Red Sea. The total value of cattle, sheep, and goats exported in 1913 amounted to £176,195.

Further information in regard to the above products and means of securing supplies may be obtained on written application to the Director of the Imperial Institute, South Kensington, S.W., and specimens of most of them may be seen in the Sudan Court of the Public Exhibition Galleries of the Imperial Institute.

Indian Mowra Seed.—Owing to the closing of German and Austrian markets consequent on the war, there are a number of Indian products, hitherto purchased in large quantities by those countries, for which Indian exporters are seeking new outlets. Amongst these is Indian mowra or mowa seed, which has so far received little if any attention from British oil-seed crushers. For several years Germany has been the chief purchaser of India's exports

of this product, and last year (1913–14) over 85 per cent. of the mowra seed shipped from India went to Germany.

The following table shows the total exports of mowra seed from India, and the quantity and value taken by Germany:

	Average for three years ending 1911-12.		1912-13.		1913-14.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	cwts.	£	*cwts.*	£	*cwts.*	£
Exports to Germany	407,228	185,710	187,054	100,020	567,670	309,791
Total exports . .	664,942	303,709	265,861	142,913	665,979	364,000

Mowa or mowra seeds are the product of species of Bassia which occur throughout the East Indies, and yield fats suitable for edible purposes. In India the fat is expressed from the kernels of the seeds and is eaten. An account of the investigation of samples of Bassia kernels and fats from India and Ceylon has already been given in this BULLETIN (1911, **9**, 228). Probably an important reason why mowra seeds have been disregarded by British oil-seed crushers is that the cake is not suitable for feeding to stock, and can only be used as manure. In view of the possibility of supplies of these seeds, which would in normal times have gone to Germany, becoming available at advantageous prices, the question of their utilisation is worthy of the attention of British oil-seed crushers and makers of edible fats.

Seed Control Stations on the Continent.—As the seed purchased by the farmer varies much in quality, and its value cannot be determined by mere inspection, it is a matter of considerable importance that he should be protected by being able to have his seed examined at a moderate fee, and this procedure has a good effect in raising generally the quality of the seed supplied by vendors. On the Continent this is carried out at seed control stations. Nine of these stations, namely those at Copenhagen, Hamburg, Wageningen in Holland, Zurich, Budapest, Vienna, Munich, Breslau, and Berlin have been visited by Mr. H. C. Long, an officer of the Board of Agriculture, and an account of the work they do forms *Supplement* No. 13 of the August number of the *Journal of the Board of Agriculture.* The first six are Government institutions, and the two next receive State grants.

The examination of the seeds is directed to their identity, place of origin, purity, germinating capacity, germinating energy, weight of 1,000 seeds, weight of a litre of the seed, and percentage of moisture. In examining the purity the points attended to are the proportions of (1) pure seed, (2) sand, dirt, chaff, waste material, etc., (3) seeds of other cultivated plants, and (4) weed seeds. A good deal of attention is given to the search for dodder. The germinating capacity is determined by treating the

seeds in various ways and for periods of time suited to their nature, and ascertaining what proportion have germinated. The proportion that have germinated at the end of about one-third of the period allowed is taken to represent the germinating energy. In stating the germinating capacity an allowance is made for "hard seeds." Various formulæ are used to give an estimate of the value of the sample. The above outline, however, does not apply uniformly to all the stations, as the methods of examination and plans of reporting naturally vary.

In the United Kingdom the examination of seeds is carried out by many different bodies. In England by the Botanist of the Royal Agricultural Society; in Scotland by the Botanist of the Highland and Agricultural Society; and in both countries at numerous colleges and laboratories, a list of which is given in the *Trans. Highland and Agric. Soc. of Scotland* (1913, **25**, 102). In Ireland there is a Seed Testing Station conducted by the Department of Agriculture and Technical Instruction, and quite recently one has been started under the Board of Agriculture, for Scotland.

Cotton Pests in German East Africa.—An account of about seventy actual or possible enemies of the cotton plant in German East Africa, mostly insects, is given in *Beiheft* No. 1, of *Der Pflanzer*, 1914, vol. **10**. Among these the following are some of the most serious.

The leaf beetle, *Syagrus puncticollis*, is about 6 to 8 millimetres long and attacks the stems of quite young plants, and also the leaf stalks and the leaves. The leaves are found pierced with holes and hanging limp and the beetles can be found in pairs in the folds. It has been observed that the beetle appeared at the commencement of the main rainy season, and the attack was most severe where the cotton followed high grass, and was scarcely noticeable where it followed maize. The insects can be shaken off into a vessel of water and petroleum, or spraying with a solution containing 1 per 1,000 of sodium arsenite may be adopted.

The small black cotton weevil, *Apion xanthostylum*, is a dangerous pest; it is 2 to 3 millimetres long and dull black in colour with white hairs which give it a grey appearance. The larvæ inhabit the base of the unripe capsules and also establish themselves in the bark and in the wood of the root top, the stem, and the twigs, and injure the growth of the whole plant.

The dreaded Mexican boll weevil, *Anthonomus grandis*, which causes such enormous losses in the United States, fortunately has not effected an entry in East or West Africa.

The larvæ of some of the moths are formidable enemies to cotton. The Egyptian cotton boll worm, *Earias insulana*, which is spread over Africa, India, and Australia, occurs

in German East Africa. The moth is a small greenish-yellow insect with a wing span of 20 to 22 millimetres. The eggs are laid on the leaf or on the growing tips or on the capsule. It is combated by clearing away weeds from the cotton plant, by collecting and burning the attacked capsules and tips, and by burning all the old plants after harvest. The larvæ feed also on other plants, and *Hibiscus esculentus* has been tried in India as a trap crop. In India, too, the introduction of an ichneumon fly, *Rhogas Lefroyi*, is said to have materially diminished the pest, and an attempt is being made to establish this fly in Egypt.

Another moth, the Egyptian cotton worm, *Prodenia litura*, and the moth just described are the greatest enemies of cotton in Egypt, but in German East Africa *P. litura* does not appear to be abundant on cotton. The eggs are laid in masses on the underside of the leaves and are covered with hairs which protect them from the wet. The larvæ when young attack in large companies the under-surface of the leaves; when older they gnaw the edges. The old worms hide during the day in the ground and only come out at night or in dull weather to feed on the plants. The change into a chrysalis is made in the ground. Besides cotton it feeds on maize and many other plants, and it occurs all over the tropical and subtropical regions of the Old World. The eggs should be carefully sought out and destroyed.

The common cotton boll worm, *Chloridea obsoleta*, is widespread in German East Africa, but so far has not been observed on cotton plants. It is a very wide-spread insect in the world and feeds on many plants; the use of insecticides and of maize as a trap crop for it have been recommended.

The pink boll worm, *Gelechia gossypiella*, is the worst cotton pest in East Africa; it is universal and every year destroys a proportion of the capsules. These are the only part of the plant that it attacks, and as soon as the first of them are set, the moths lay from one to three eggs on each. After hatching the worms bore their way to the seeds, which they eat out. The entrance hole cicatrises and the worm gets ready an exit hole and then pupates in the hollow seed or in a bore hole. In older capsules the worm pupates either in an empty seed or between several seeds, and the seed stored for use still contains the insect in some form. The life cycle of the insect in the active period lasts from four to six weeks; the first attack of the year is always slight, and subsequent attacks get more and more severe. The winter seems to be passed in or among the seeds, but this is not quite established; it may perhaps be passed by the aid of other food plants. It is combated by collecting all the attacked

capsules as soon as possible and by clearing away and burning the old plants after the harvest. During the harvest, too, all attacked capsules should be put by the cotton gatherers into a separate sack and burnt each day. A further precaution is to expose the gathered material on metal plates in the sun and thus destroy the worms. Spraying is unsuitable, but the seeds might be disinfected with carbon disulphide; not with hydrocyanic acid, however, since this has been found ineffective.

Of the cotton stainers, *Dysdercus* spp., four occur in German East Africa, as also does *Oxycarenus hyalinipennis*, but in general the damage they do is insignificant.

In one year enormous quantities of snails appeared in the south of the Protectorate and large places in the cotton fields were eaten bare by them, and sometimes the cotton plants were broken by the load of snails. They came from the surrounding bush and grass-land, and the remedy proposed was to make ditches of water round the fields so that the snails could not pass. Such an attack, however, seems very exceptional.

The Source and Industrial Uses of Beryllium Compounds.—The preparation of the beryllium nitrate, used in the manufacture of incandescent gas mantles, has hitherto been carried on entirely in Germany. As a consequence of the European war there was a temporary scarcity of this and other beryllium salts, but it is understood that British chemical manufacturers are now prepared to put these salts on the market. The industry is a small one, but as the matter is of considerable interest the following note as to the source and uses of these salts has been prepared.

Beryllium, or glucinum, is a constituent of many minerals, few of which are found in any quantity. The only important one is *beryl*, the better-class varieties of which are valued as gemstones.

Beryl is a silicate of beryllium and aluminium, usually of a pale green colour. It has a hardness of 7·5 to 8, specific gravity 2·6 to 2·8, a vitreous lustre and conchoidal fracture. It often occurs, as an accessory mineral, in pegmatitic granite veins, in hexagonal prisms which sometimes attain a great size.

The mineral is of common occurrence in the pegmatites of India, and large crystals have been found in the mica mines of Behar and Nellore. In the United Kingdom it has been found in the Mourne Mountains of Co. Down, and at Killiney near Dublin, Rubislaw near Aberdeen, and St. Michael's Mount, Cornwall.

In New South Wales, beryl occurs, associated with tinstone, at Elsmore, Mole Tableland; with felspar, quartz, and mica at Ophir, Wellington Co.; at Shoalhaven River, east of Bungonia; and in alluvial deposits at Emmaville, Kangaroo Flat, Tingha Copes Creek, and Scrubby Gully.

In the United States, beryls of great size have been found in New Hampshire and Massachusetts, certain of which weighed over one ton. The mineral has also been found in many other localities in the United States, Russia, Sweden, Norway, Colombia, Brazil, etc.

The following is a typical analysis of beryl:

		Per cent.
Beryllium oxide	BeO	12·64
Aluminium oxide	Al_2O_3	17·05
Ferric oxide	Fe_2O_3	2·20
Lime	CaO	0·57
Soda	Na_2O	0·68
Silica	SiO_2	65·24
Water	H_2O	2·70

Preparation of Beryllium Compounds.—Several processes are available, of which the following may be mentioned. The finely powdered beryl is mixed with twice its weight of dry potassium carbonate and fused for three hours. The melt is treated with a slight excess of dilute sulphuric acid, and the whole evaporated until the excess of acid is removed. Water is then added, the insoluble silica removed by filtration, and the solution concentrated so that, on cooling, the greater part of the aluminium crystallises out as potash alum. The mother liquor, which now contains sulphates of beryllium and iron together with a small amount of alum, is poured into a saturated solution of ammonium carbonate, and allowed to stand for several days. By this means most of the iron and aluminium separates out, and is removed by filtration. The solution in ammonium carbonate is next treated with superheated steam, which causes the beryllium to be precipitated as a basic carbonate.

By repeating this solution in ammonium carbonate, and precipitation with steam several times, a fairly pure product can be obtained.

The preliminary fusion with potassium carbonate may be replaced by one using six parts of ammonium fluoride to each part of beryl, and continuing the heating for ten to twelve hours. On extracting the mass with water, most of the aluminium remains as the insoluble fluoride, and the filtrate is evaporated with sulphuric acid to remove the silica and hydrofluoric acid. The solution is diluted and treated with ammonium carbonate as above. From the carbonate so obtained, other salts, such as the nitrate, can be readily prepared by well-known methods.

Commercial Utilisation of Beryllium Compounds.—Very few uses have been found for salts of beryllium, and, so far as can be ascertained, the only industry which calls for regular supplies is that of making incandescent gas mantles. In the solutions of thorium salts used for impregnating the

ramie, cotton, or artificial silk "stocking," a small quantity of beryllium nitrate is sometimes used in order to give increased strength to the ash skeleton which will remain after ignition. The quantity of beryllium salt added rarely exceeds 0·5 per cent. of the weight of thorium nitrate present in solution. Beryllium acetate has been suggested for use as a catalyst in the preparation of certain organic compounds.

In the past it would appear that the small trade in beryllium minerals, other than gemstones, has been largely centred in Hamburg. Recent prices are not obtainable, but during 1911 high-grade beryl sold at £2 to £2 10s. per 100 kilos. c.i.f. Hamburg. The mineral was then largely obtained from Norway, one producer stating that he sold from 3 to 10 tons per annum.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India, and the Tropics generally.*

SOILS

Droughts and Soil Erosion in South Africa.—The inland portion of the Union of South Africa is exceedingly liable to droughts, which are steadily increasing in severity and are accompanied by serious soil erosion, with the result that certain large areas of land have already been rendered useless and many other areas are threatened with the same fate. In view of these facts a Select Committee was appointed in March 1914 to consider the question of droughts, rainfall, and soil erosion, and their Report has now been issued, together with the Proceedings of the Committee, Minutes of Evidence, and Appendix [*Senate S.C.* 2—1914].

The consideration of the Committee was devoted to four subjects: (1) The rainfall of South Africa: its occurrence and variation; (2) erosion of the soil: its causes and extent; (3) desiccation; and (4) possible remedial measures.

With regard to the rainfall, there does not appear to have been any definite diminution during the period for which records are available. There has always been considerable variation in the distribution and nature of the rainfall from year to year and from month to month, and this variation increases with the distance from the coast. Some evidence has been obtained indicating that there

are periods of maximum and minimum rainfall corresponding with certain cycles, but this is not sufficient to enable any such cycles to be defined. The condition of the soil and the vegetation on it do not affect appreciably the total amount of the rainfall, although it probably influences its local character and distribution.

When erosion of the soil has commenced, its continuation is greatly facilitated by the high elevation of the South African sub-continent and the consequent rapid run-off of the rain-water. Various agencies have contributed to the denudation of the soil, such as the burning of the veld, the cutting of trees and bush for fuel or timber, railway construction, and the grazing of stock. Much damage has been caused by the way in which roads and tracks have been made; in many parts these have been laid without any regard to construction or drainage, and become converted by the ordinary traffic of the country into channels, down which the rain-water rushes from the slopes into the main valley, carrying with it the loosened portions of the surface soil. The combined effect of these different factors has resulted not only in the waste of rain-water which would have been of great value to agriculture, but also in causing the irretrievable loss of much of the richest soil.

There is no doubt that, in spite of the apparent constancy of the total rainfall, many parts of the Union have been gradually drying up at a rate varying with the locality, soil, and gradients. Unless this process is checked, such parts of the country must ultimately become useless and uninhabitable. The direct cause of the desiccation is the erosion of the soil and the consequent diminution or disappearance of the water-supply.

The erosion has progressed to such a vast extent and for so long a time as to render it impossible to check it completely. Various measures are suggested for reducing and controlling the evil. These include (1) the instruction of the public by means of pamphlets and lectures with regard to the seriousness of the danger, the causes and effects of erosion, the best means of stopping sluits, and the most suitable trees and grasses to grow for the purpose; (2) the periodical inspection of districts in which erosion is in active progress; (3) the encouragement of fencing and the construction of dams and irrigation works; (4) legislation against indiscriminate veld-burning; (5) the regulation of grazing; (6) the encouragement of the judicious planting of trees and sowing of grasses; (7) the proper construction, drainage, and upkeep of roads; and (8) the minimising of erosion in connection with both existing and future railways. It is pointed out that the greatest obstacle to the attainment of rapid results is the sparsely populated state of the country, and it is considered that

a closer settlement of the land would render efforts to check erosion much more effective in all respects.

Treatment of Hard-pan Land in Egypt.—On some kinds of land a hard, impervious layer is formed at a little distance below the surface of the soil; it prevents drainage and stops the penetration of roots, and consequently impairs the fertility of the soil. This layer is known as hard-pan, and is caused by different agencies in different places, such as organic matter, iron compounds, siliceous compounds, etc., or it may be caused by sodium carbonate in the soil.

In the Nile Delta there are several localities where nothing will grow owing to the presence of sodium carbonate. On one estate an endeavour to wash the sodium carbonate out of the soil produced a hard-pan at some depth below the surface, so that water stood on the surface whilst the surrounding drains remained only slightly moist, showing that percolation had practically ceased. An account of the way it was treated and the condition ameliorated is given in the *Agric. Journ. Egypt* (1914, **4**, 61). At first an attempt was made to break up the pan by the use of explosives. Gelignite cartridges were exploded at a depth of about 30 in. and at a distance of 4 or 5 yards apart. The explosion of these should have caused radiating cracks in the hard-pan, but the land was so wet that in most cases the effect was merely to blow up the soil above the cartridge, and the water still stood for days in the hollows caused by the explosion. The area treated was about five-twelfths of an acre, and the cost of the explosives was a little over £2, 24 lb. of gelignite being used, with the necessary detonators and fuse.

The next attempt was more successful; this was to apply gypsum in order to decompose the sodium carbonate. Three applications of this were made in dressings of 15¾ cwts., 17¾ cwts., and 14¾ cwts., with frequent ploughings. The result was that the whole nature of the soil seemed greatly improved; and this was probably due far more to the gypsum than to the explosives.

Foodstuffs

Coffee.—The export of coffee from the East Africa Protectorate during the year 1912–13 amounted in value to £10,680, having increased each year from £1,068 in 1909–10 (*Ann. Rep. Dept. Agric., Brit. East Africa*, 1912–13). The discovery of *Hemileia vastatrix* on two plantations caused uneasiness amongst planters. It was found that the disease had been in existence on a third plantation for some years without however having a serious effect on the yield of coffee. This information, together with the fact

that in German East Africa coffee has been grown with substantial profit for the last ten years, notwithstanding the presence of Hemileia, has given encouragement to plantation owners, and further it has been found that the disease is not proving so disastrous as was at one time feared. A series of experiments was conducted with various fungicides, but the results did not indicate the prospect of any substantial benefit from spraying as a general practice. A similar result was obtained in India.

Sugar.—*The Rep. Dept. Science and Agric., British Guiana*, 1912–13, records the results of further manurial trials with sugar-cane during a season in which the rainfall was much below the average. Contrary to the results obtained in other years, the manurial value of nitrate of soda proved higher than that of sulphate of ammonia, for which in normal years the sugar cane shows a marked preference. In seasons when the period of active growth is short, nitrate of soda and nitrate of lime may be more efficacious than sulphate of ammonia, dried blood, cyanamide, and other more slowly acting nitrogenous manures.

The results obtained by the application of vacuum-pan molasses at rates of 100 to 300 gallons per acre indicated that molasses exerted no appreciable action on the crop to which it was applied, and that its application resulted in a financial loss. Whether it exerts a beneficial action on later crops has not yet been determined. It is alleged to have a favourable action on soil bacteria.

According to the *Report, Government Statistician, Queensland, on Agricultural and Pastoral Statistics* for 1913, the cane crop of Queensland for 1913 surpassed in quantity and quality all previous harvests in this state. There were in 1913 147,743 acres under cane, of which 102,803 were cut for crushing, yielding 242,837 tons of sugar, as against 141,652 acres cultivated in 1912, of which 78,142 were cut for crushing, yielding 113,060 tons of sugar. The best average cane return per acre was in Wide Bay, where 21·7 tons were harvested, while the best average return of sugar per acre was obtained in Edgecumbe, and amounted to 2·43 tons. Of the total Australian output of sugar in 1913, amounting to 266,267 tons, Queensland produced 91·2 per cent., and New South Wales 8·5 per cent., while Victoria contributed 857 tons of beet sugar, representing 0·3 per cent. of the total.

The value of the Nipa palm (*Nipa fruticans*) as a commercial source of sugar is discussed in *Philippine Journ. of Science* (1913, **8**, 377). The Nipa palm covers large areas of swamp land in various parts of the tropics and has but few requirements for successful growth, among which may be mentioned low river land subject to periodic flooding. The sap at present is utilised as a commercial source of alcohol, and is collected in bamboo joints or "tuquils" from

the cut flower stalks, where it is slowly exuded. Owing to the inversion and fermentation which take place during the collecting process now employed, the sap is useless for the manufacture of sugar. As a result of the experiments carried out by the Philippine Bureau of Science this difficulty has been overcome in the following manner. The sap is collected in bamboo joints containing a small amount of lime-cream and sodium bisulphite. The lime prevents inversion of the sucrose, and the sulphite destroys an enzyme of the peroxidase class present in the sap which is capable of rapidly destroying both sucrose and invert sugar. By the use of a small funnel the sap is conveyed to the bottom of the tuquil and stratification with the resulting uneven preservation is prevented. It is stated that Nipa sap can be collected and delivered at a mill at a cost of 1,000 litres for 1½ dollars (U.S. currency), and this quantity of sap yields 115 kilograms of commercial white sugar, polarising at 99° to 99·5°. A 10-ton mill running at full capacity requires 90,000 litres of sap daily, which would be supplied by a swamp of about 1,100 acres. Further details of extraction are given, and it is stated that the production of sugar from Nipa palm would be less expensive than from cane or sugar beet.

An account of the sugar palm (*Arenga saccharifera*) is contained in *Philippine Agric. Review* (1914, **7**, 216, 222). In the Philippines the sap is a source of alcohol, vinegar, starch, and sugar, but owing to the protein substances held in solution, and to the rapid fermentation of the sap, it has not been possible to produce a first-class sugar. The article records experiments in which formalin was found to be the most satisfactory preservative of the juice, and that by heating the sap to the boiling point the protein and pectous bodies were precipitated. One tree, it is stated, yields about 385 kilograms of sap per year, containing 14 per cent. of sucrose.

Wheat.—*The Ann. Rep. Dept. Agric., Brit. East Africa*, 1912–13, contains an account of wheat-breeding experiments conducted on the Kabete Experimental Farm and on Lord Delamere's Farm at Njoro. A list of forty-seven varieties, showing the yield and dates of harvesting, is given. A number of wheats have been produced which have now successfully withstood rust infection for three consecutive seasons, and which, in addition to this property, possess a good yielding capacity, with stiff straw and awnless ears.

Oils and Oil Seeds

Coconuts.—The interest in coconut planting in British Guiana is increasing, and considerable expansion is expected (*Rep. Dept. Science and Agric.*, 1912–13, p. 9).

The total area under coconuts in 1912 was 13,698 acres. Little attention is paid to drainage, and overcrowding occurs on the older plantations, but there is an improvement in spacing in newer plantations. On neglected plantations disease is prevalent and many trees die for want of drainage. Bud-rot is not uncommon in some parts, and beetles were prevalent in many plantations, while the caterpillars of *Brassolis sophorae* have caused much damage. Legislation will be necessary to deal with insect and fungoid pests.

From Jamaica the export of coconuts showed an increase in 1913 of 820,000 nuts over that of 1912, in spite of adverse conditions in the west of the island, due to cyclones in the previous year (*Rep. Dept. Agric. Jamaica*, 1913–14, p. 15). Bud-rot is under control in the important coconut districts, but the fungoid leaf disease known as "leaf-die-back" proved troublesome in some localities.

The development of coconut planting in the East Africa Protectorate is slow, considering the large area of suitable land in the coast-belt (*Ann. Rep. Dept. Agric., Brit. East Africa*, 1912–13, p. 16). This is due mainly to the difficulty of land allotment owing to tribal claims. The *Oryctes* beetle has been present for many years, and legislation will be necessary to compel the natives to destroy the dead trees which form breeding grounds for this pest. Bud-rot appeared on two plantations grown from seed obtained from Ceylon and Pemba. All affected trees have been destroyed and the importation of seed has been prohibited, as good local seed is available.

Bordeaux mixture has been tried in Surinam as a remedy for bud-rot (*Trop. Agriculturist*, 1914, **43**, 21 ; and this BULLETIN, 1914, **12**, 645). It appears to exert a favourable influence, although it is not an absolute cure. Ten-year-old palms require about $1\frac{1}{2}$–$1\frac{3}{4}$ gallons each.

Ground Nuts.—An account is given in *L'Agron. Col.* (1914, **2**, 1, 34) of experiments which have been made in French West Africa in connection with the cultivation of ground nuts. It was found that the China and Burma varieties possessed characteristics which render them unsuitable for cultivation in Senegal. The best results are stated to have been obtained from the Kafrine and Sine Saloum varieties.

Linseed.—An account is given in the *Ann. Rep. Dept. Agric., Brit. East Africa*, 1912–13, pp. 90, 110, of trials which have been made in the cultivation of linseed in the East Africa Protectorate. It is stated that at the Kibos experimental farm the results after three years' trial are hardly of a sufficiently satisfactory character to warrant the widespread cultivation of linseed at Kibos. At the Nairobi experimental farm, Kabete, on the other

hand, excellent crops of seed are stated to have been obtained. Ten acres of land were planted with Riga seed during 1912 at Kabete, and the yields obtained were at the rate of 720 lb. of seed per acre.

Olive.—According to *Der Tropenpflanzer* (1914, **18**, 350), experiments have been in progress for some time in Leganga, German East Africa, in connection with the cultivation of olives. Trees were obtained from Palestine and planted in the Kilimanjaro and Meru districts, where the olive tree also occurs wild. The results of the experiments are stated to have been encouraging.

Sesamum.—Two varieties of sesamum have been experimentally cultivated in Rhodesia for several seasons, but although the plants grow very readily the yield of seed is said to be too low to make its cultivation remunerative (*Rhodesia Agric. Journ.*, 1914, **11**, 907). The yields per acre of the white and yellow seeded varieties are stated to have been only 140 lb. and 224 lb. per acre respectively.

Soy Bean.—The *Board of Trade Journ.* (1914, **86**, 385) states that a new experimental bean mill belonging to the South Manchuria Railway Company has started operations at Ji-ji-ko, about two miles from the Dairen wharves. The mill is the only one in Dairen which extracts soy bean oil by the benzine process, and the experiment is being made in order to see whether the more modern method could be profitably employed in Manchuria. The mill is equipped for the manufacture of crude oil and bean meal from soy beans, and for the refining of the crude oil obtained. It is said to have a maximum capacity of 80 tons of beans per day of 24 hours, but at present only 50 tons per day are treated, producing 7 tons of oil and 40 tons of meal. It is stated that it is impossible to say yet whether the experiment will give satisfactory results from a commercial point of view, as the capital cost of the mill is much greater than for a mill of the ordinary type, and the crude oil must be refined and deodorised before being put on the market.

Miscellaneous.—A monograph by E. W. Thompson entitled *Cottonseed Products and their Competitors in Northern Europe*, Part 1, Cake and Meal (*U.S. Dept. Commerce, Special Agents Series*, No. 84, 1914) has already been referred to in this BULLETIN (1914, **12**, 462, 576). The chief aim of the author is to point out the possibilities of placing larger quantities of American cotton-seed cake and meal on the various markets of Northern Europe. The trade and agriculture of Germany, the United Kingdom, the Netherlands, Denmark, Norway, and Sweden, as affecting cotton-seed cake and similar materials, are discussed in a most able

manner: while the methods of manufacture and utilisation of oil cakes are described, and lists of names of manufacturers and buyers of oils and oil cakes are also given. Although the primary object of this work is to show American manufacturers methods of extending commerce, the information given cannot fail to be of great value to all who are interested in the oil and oil cake trades, especially at the present time.

According to the *Journ. Soc. Chem. Ind.* (1914, **33**, 556), the Bureau of Science of the Philippine Government is investigating a new oil-nut from the island of Catanduanes. The nuts were forwarded by the natives as candle nuts, but it is thought that they are derived from a species of *Amoora* or *Dysoxylum*, N.O. Meliaceæ. The dry nuts are said to contain 45 per cent. of a dark, fatty, non-drying oil, unsuitable for edible purposes, but producing, it is stated, a good commercial soap.

An account is given of "Analyses and Uses of Brazilian and Indian Nutmegs" in a booklet by A. G. Turner, published recently in Liverpool. It is stated that the wild nutmegs of South America and India yield fats of considerable value to soap and candle manufacturers, but that there is some doubt as to the quantity of material available, although there is apparently a possibility of ucuhuba nuts (*Myristica bicuhyba*) being shipped in quantity to the English market from Brazil. It is stated also that if the seeds of *M. canarica* could be obtained in large quantities there would be a ready market for them, as they compare favourably with seeds of the same species obtained from other countries.

According to Davidsohn (*Seifenfabrikant*, 1914, **34**, 178), rice oil on keeping separates into a liquid oil and a solid fat. Constants of both are given, and it is stated that the oil is suitable for the manufacture of soft soaps, whilst the fat (the mixed acids from which melt at 39·6° C.) is suitable for hard soaps.

An account is given in *Journal d'Agric. Tropicale* (1914, **14**, 171) of fruits and seeds of *Balanites Tieghemi*. The kernels, which comprise 21 per cent. of the seeds, are from 1 to 2 in. in length, and yield 10 per cent. of a liquid yellow oil containing 63 per cent. of unsaturated acids. It is stated that the colour and taste of the oil prevent its use as an edible oil, but it is regarded as suitable for soap making. Constants of the oil and the results of analysis of the cake are given.

The total capacity of hydrogenating plants for the hardening of liquid oils (see this BULLETIN, 1913, **11**, 660) in Europe in 1914 has been estimated to be about 1,375,000 lb., but only about one-half of this quantity was manufactured in 1913 (*Journ. Soc. Chem. Ind.*, 1914, **33**, 837). In the United States of America there existed in 1913

plant capable of turning out about 500,000 lb. of hydrogenated oils, and the industry is increasing rapidly. In Europe linseed oil has been used, chiefly owing to its present low price; cotton-seed oil has been used for the preparation of edible fats. Manufacturers of compound lard in the United States who previously used 20 per cent. of oleo-stearin (animal fat) now use only hardened cotton-seed oil. In Germany the two largest factories making hardened oils are the Bremen-Besigheimer Oelfabrik, where only edible fats are produced under the name "Brebesol," and the Germania works at Emmerich, which produce hardened oils for technical use, such as "talgol" and "candelite," from whale and fish oils (*Journ. Soc. Chem. Ind.*, 1914, **33**, 872). The former works employ the Messerschmidt iron-contact process for generating hydrogen at a cost of about 1*s.* 1¼*d.* per 1,000 cubic feet.

Rubber

Hevea brasiliensis.—According to Dr. Arens, who made a tour recently through Ceylon and Malaya, little or no systematic attempt has been made to plant selected Para rubber seed in these countries (*Trop. Agriculturist*, 1914, **43**, 10). In Java many plantations have been made already, from seed of specially good trees, and the author cites the results obtained with cinchona in Java as an example of what may be done by attention to selection. A note by the editor of the *Tropical Agriculturist* states that a field has been planted at Peradeniya with seed from the well-known tree at Henaratgoda, which has yielded 386 lb. of rubber in four years.

The growth of Hevea trees in British Guiana is satisfactory when planted on suitable land, such as that which has supported a heavy forest growth. The industry is expanding slowly, there being 2,800 acres under *Hevea brasiliensis* in the year 1912–13 (*Rep. Dept. Science and Agric., Brit. Guiana*, 1912–13, p. 10). In that year nearly 120,000 plants were raised from seed imported from Ceylon and the Straits Settlements, while over 110,000 stumps were imported from Ceylon and Surinam.

According to the *Rep. Dept. Agric., Jamaica*, 1913–14, p. 15, eight-year-old Hevea trees tapped for six months yielded only a small amount of scrap rubber, showing that Hevea is unsuitable for cultivation in Jamaica; no details as to method of tapping or state of growth of the trees are given.

The growth of Hevea trees in Nyasaland is stated to be about two years behind that in Ceylon (*Rep. Dept. Agric., Nyasaland*, 1913–14, p. 10), but considering the drought to which they have been subjected their growth appears to be satisfactory. Experimental tapping of some trees has given satisfactory results. There are over

100,000 trees from one to seven years old on the plantations of the African Lakes Corporation, Ltd.

In *Bulletin* No. 19, 1914, *Dept. Agric., Fed. Malay States*, A. Sharples describes the various fungi which cause spots on rubber, and discusses the conditions which favour the formation of spots and also methods of prevention. The main conclusions arrived at are: (1) Spotting and discoloration of plantation rubber are generally due to common saprophytic fungi (*Penicillium* sp., *Fusarium* sp., etc.), which contain proteolytic enzymes. (2) Infection takes place in the latex in the field; infection of the rubber after preparation only takes place under abnormal conditions in the drying sheds. (3) The best methods of prevention are treatment of the latex by formalin and quick drying of the rubber by thinner working and "addition of sodium bisulphite," although the author's evidence that sodium bisulphite accelerates drying does not appear very conclusive. (4) Dilution of the latex with water tends to enhance the danger of spotting. (5) Excess of coagulant also increases the tendency towards spotting. The *Bulletin*, which contains the results of much original investigation, will be of considerable value to rubber planters.

Funtumia spp.—According to the *Bulletin agricole du Congo Belge* (1914, **5**, 95) *Funtumia elastica* occurs wild in abundance in all the forests of the Bangala district, Belgian Congo. Plantations have been made at Musa and Kutu since 1904; those in the latter place were made, however, in cleared forest, and the results were unsatisfactory, while the Kutu experiment station has since been abandoned. In experiments carried out with 620 trees eight to nine years old at Musa, tapped on alternate days over a period of ten or eleven days, nearly 134 lb. of rubber, containing from 15 to 20 per cent. of moisture, were obtained; allowing 20 per cent., the yield of dry rubber is equivalent to 2¾ oz. per tree. The trees could probably be tapped twice a year, and including scrap, a yield of about 6 oz. of dry rubber per tree per year may be expected. The trees were planted at distances of 3 × 3 metres, the yield per hectare being calculated at 407 lb. of dry rubber per year, equivalent to 164 lb. per acre. Experiments with a large number of trees at Kutu gave similar results. The cost of production was somewhat high (about 7*d.* per lb.) owing to unskilled tapping. The rubber was valued at about 2*s.* 2*d.* per lb., with plantation Hevea rubber at 2*s.* 4*d.* per lb.

Miscellaneous.—The cultivation of *Sapium* in British Guiana has not given promising results (*Rep. Dept. Science and Agric.*, 1912–13, p. 10), and most of the plantations will be abandoned.

According to the *Rep. Dept. Agric., Nyasaland*, 1913–14,

p. 10, Ceara trees only produce satisfactory yields in that country when grown on rich soil retentive of moisture and in localities with a rainfall of not less than 40 in.

Fibres

Silk.—In the *Rep. Dept. Agric., Travancore, for the Year* 1912–13, an account is given of an effort which is being made to encourage silk culture. Experiments have been carried out at the Chingom Silk Farm with both mulberry and eri silkworms and with mulberry and castor-oil plants. The chief attention has been given to the eri silkworm, as this is regarded as more likely to become popular with the natives. Lectures and demonstrations have been given at several places, and leaflets on sericiculture have been distributed broadcast. Mulberry cuttings, castor-oil seeds, and silkworm eggs have been supplied to a number of persons, and considerable interest in the industry has been aroused. There is no doubt that Travancore is well adapted to sericiculture, and it is hoped that it will be taken up largely as a cottage industry.

Flax.—The experiments on flax cultivation which have been conducted for many years by the Department of Agriculture and Technical Instruction for Ireland (compare this BULLETIN, 1903, **1**, 188; 1912, **10**, 498; 1913, **11**, 532) have been continued, and an account of the work accomplished during 1912 is published in the *Journ. Dept. Agric. and Techn. Instr., Ireland* (1914, **14**, 515). The use of steamed bone flour as a manure has been tested for four successive years and has given adverse results. As similar results were obtained in earlier experiments with other phosphatic manures, viz. superphosphate and basic slag, it is now definitely concluded (1) that in the districts in which the experiments have been carried out, phosphates cannot be profitably applied to flax, and (2) that this is due to the fact that they encourage the growth of weeds to such an extent as seriously to reduce the flax crop. A series of trials on the application of lime and muriate of potash to the flax crop, the lime being applied the previous year to oats, have indicated that the liming of the land one year in advance is of considerable benefit and that muriate of potash forms a valuable supplemental dressing to lime. Further experiments are needed, however, before definite recommendations can be made. In the course of special trials of Russian, Dutch, and Irish flax seed, results have been obtained which indicate that an improved variety of flax can be obtained by the process of selecting seed from plants with long stalks.

In the *Ann. Rep., Dept. Agric., Brit. East Africa*, 1912–13, it is stated that the flax plant has been grown in several districts of the Protectorate during the last two

years for the production of linseed only, the straw being burned (see p. 620). A small quantity of fibre was prepared however, as an experiment, and this was so favourably reported on that the services of a flax expert from Courtrai, Belgium, were secured. This expert has demonstrated that fibre of a high quality can be produced in the East Africa Protectorate. A sample of the flax was valued by a London fibre mèrchant at £65 per ton, a price which was only £10 per ton below that of the best Belgian flax. The cultivation of flax is being extended and a scutching factory has been established at Lumbwa. A crop of over 2½ tons per acre has been obtained at Kabete on unmanured land, and as all the work involved, except scutching, can be carried out by unskilled labour, it is expected that the industry will undergo a rapid development. It may be mentioned that samples of flax grown in the East Africa Protectorate have been examined at the Imperial Institute, and these also proved to be of excellent quality (this Bulletin, 1914, **12**, 211).

Sisal Hemp.—A record of the progress of the sisal hemp industry in the East Africa Protectorate is given in the *Ann. Rep. Dept. Agric., Brit. East Africa*, 1912–13. The returns from the plantations have been so satisfactory that a considerable extension of the industry is anticipated. At the end of 1912, the total area under cultivation was about 7,000 acres, distributed as follows: Punda Milia, 1,000 acres; Makuyu, 750 acres; Voi, 1,000 acres; Nyali, 1,000 acres; Powysland, 1,160 acres; Gazi, 1,000 acres; Maseno, 600 acres; other areas, about 490 acres. Several improvements have been made in the decorticating machinery, and simplified methods of brushing and drying the fibre are being adopted which will effect an economy in labour. Sisal plants grown at the coast yield a higher percentage of fibre than those grown in the highlands and also furnish a finer fibre, but in the highlands a larger yield per acre is obtained and the cost of labour is less. The following data were obtained as the result of certain tests carried out at Punda Milia. From 912 leaves, weighing 2,263 lb., or an average of 2·48 lb. per leaf, a yield of 52½ lb. (2·32 per cent.) of dry, brushed fibre was obtained, or about 1 lb. of fibre from 17 leaves. The plants from which these leaves were cut were spaced 8 ft. × 8 ft., this arrangement giving 681 plants per acre. Taking 160 as the average number of leaves produced per plant during its life, the total yield per acre, when calculated by the above figures, is 6,240 lb., or a little less than 3 tons. Considerable attention is being devoted to the question as to the best treatment of the land after the full crop has been gathered in order to render it fit for further planting. It is suggested that the stumps would dry more quickly if small quantities of arsenite of soda were injected into

them. They could then be collected and burned and the land ploughed again before weeds had become established to any great extent. Experiments are being conducted on these lines at Punda Milia.

An interesting account of the present position of the various sisal hemp estates in the Protectorate is given by the Chief of the Economic Plant Division. The experience gained by Messrs. Swift and Rutherford at Punda Milia has led to the following conclusions : The establishment of a plantation of 1,000 acres requires a capital of £4,000. The cost of machinery required to prepare the fibre from leaves produced on 1,000 acres is £5,000. A return cannot be expected until at least four years after the plantation has been established. One ton of dry fibre per acre per annum may be anticipated for three years from the date of the first cutting. The cost of producing a ton of dry fibre is about £12, including £1 per ton for transport to the railway.

New Zealand Hemp.—An account of the New Zealand hemp (*Phormium tenax*) industry in St. Helena during 1913 is given in *Colonial Reports*, *Annual*, No. 799, *St. Helena, Report for* 1913 [Cd. 7050–40]. The quantity of leaves treated at the Government mill amounted to 1,296 tons, and yielded 128 tons of fibre and 39 tons of tow. The fibre realised an average price of £28 10*s.* per ton, and the tow £14 10*s.* per ton. The year's working resulted in a net profit of £137, and the results are regarded as very satisfactory. A new mill was opened by a private firm in July 1913, and by the end of the year had dealt with 589 tons of leaves, with the production of 38 tons of fibre and 14½ tons of tow. The amount of phormium now under cultivation is considered sufficient to ensure a continuous supply of leaves to both mills. Further planting is being carried out every year, and ere long there should be enough material available to justify the erection of a third mill.

Paper-making Materials.—The attention of the Research Institute, Dehra Dun, India, has been drawn to "moya" grass (*Pennisetum Alopecuros*) as a possible paper-making material. It is reported in the *Indian Forester* (1914, **40**, 291) that this grass yields 39 per cent. of pulp, which can be easily bleached, and is similar in quality to that obtained from baib grass (*Ischaemum angustifolium*). Moya grass is said to grow over large areas in the hills of the Central Provinces, and to be capable of collection at a low cost. It is considered that in the neighbourhood of the Pench Valley coalfield 15,000–20,000 tons could be collected annually and delivered at a suitably situated factory site at a cost not exceeding Rs. 15 (£1) per ton.

A sample of the stems of *Hedychium flavescens* has been forwarded to Kew by the Director of Agriculture, Ceylon,

in order that its paper-making qualities might be compared with those of *H. coronarium* (cf. this BULLETIN, 1913, **11**, 163; 1914, **12**, 487). This material has been tested by Messrs. Clayton Beadle and Stevens, and their report has been published in the *Kew Bulletin* (1914, No. 5, p. 193). The results of the investigation show that the stems of *H. flavescens* furnish a paper of similar character to that afforded by the stems of *H. coronarium*, but in somewhat lower yield.

Cotton

Uganda.—The cotton industry of Uganda has continued to make remarkable progress, especially in the Eastern Province. The *Ann. Rep Dept. Agric., Uganda, for the year ended March* 31, 1914, states that the total area devoted to cotton in that year amounted to 83,714 acres, consisting of 33,738 acres in the Teso District, 25,000 acres in the Busoga District, 20,104 acres in the Bukedi District, and 4,872 acres in the Lango District. The exports amounted to 85,217 cwts. of ginned cotton of value £272,366, and 44,130 cwts. of unginned cotton of value £45,321. The further extension of the industry is seriously hampered by the difficulties of transport. The whole of the main crop of cotton during the season under review was of Allen's Long Staple variety. During the 1914–15 season the same variety will be grown over the greater part of the country, but about 6,000 acres will be planted with a selection of the Sunflower variety produced at the Kadunguru seed-farm.

East Africa Protectorate.—It is stated in the *Ann. Rep. Dept. Agric., Brit. East Africa*, 1912–13, that the experience of several years has proved that the cultivation of cotton in the coast belt is not profitable, except on the banks of the Tana and Juba Rivers, where irrigation can be effected. In the Lake District of the Nyanza Province, however, favourable conditions of soil and climate exist, and cotton growing is being taken up by the natives as an adjunct to the cultivation of sim-sim (sesame) and other food crops; it is anticipated that in the near future considerable quantities of cotton will be exported from this district.

Nyasaland.—An account of the cotton industry in Nyasaland is given in the *Ann. Rep. Dept. Agric., Nyasaland Protectorate, for the year ending March* 31, 1914. The area devoted to the crop by European planters during the season 1913–14 amounted to 25,697 acres, of which 160 acres were planted with Egyptian cotton and the remainder with the Nyasaland Upland variety. The total exports amounted to 6,003 bales of 400 lb., as compared with 8,093 bales in the previous year; the decrease was due to the failure of the crop in the Shire Highlands, owing to unfavourable climatic conditions. The cotton grown on many of the

estates showed a decrease in length, and planters are strongly advised to procure seed yielding cotton of a length of $1\frac{3}{16}$ in. instead of $1\frac{1}{8}$ in., as the difference of $\frac{1}{16}$ in. in length makes a difference of at least 1*d.* per lb. in the value of the cotton Cotton growing by the natives continues to undergo a steady extension, and during the year under review the crop amounted to 1,811 bales of 400 lb., as against 1,126 bales in 1912-13.

Jamaica.—The cotton crop of 1913 attained the value of £4,000. It consisted of the Sea Island variety, and was mostly grown by the small holders in Vere (*Ann. Rep. Dept. Agric., Jamaica, for the year ending* 31*st March* 1914). The 1914 crop, however, failed on account of an abnormal season, and planters have therefore sought for a more hardy variety for general cultivation. A perennial tree-cotton has been introduced from Cauto in Cuba, and has given very promising results. This variety is expected to form the basis of a reliable industry for both large and small growers in the drier districts of the island. Experiments are also being made with three kinds of Egyptian cotton, including the Sakellaridis variety.

A series of specimens of the Cauto cotton plant have been forwarded from Jamaica to Kew, and have been reported on (*Kew Bulletin*, 1914, No. 5, p. 198) as follows: "The specimens agree in most of their technical characters with *Gossypium brasiliense*, Macf., from which they differ, however, in the seeds being free from one another. In view of the statement that Cauto cotton is wild or semi-wild in south-eastern Cuba, it may possibly represent the wild stock of *G. brasiliense*; and having regard to its close agreement with that species, apart from the free seeds, it has been provisionally named *Gossypium brasiliense* var. *apospermum*, Sprague (var. nov.), as it seems desirable to have a definite name for such an important economic plant. At the same time, the possibility of its being a hybrid of *G. brasiliense* with some other species cannot be entirely excluded. The study of its behaviour on cultivation may perhaps throw some light on this point."

Fiji.—An account of experiments carried out at the Lautoka Experimental Station during 1913-14 is given in the *Fiji Royal Gazette* of October 9, 1914. Two kinds of Sea Island seed were sown; one of these was obtained from Barbados in 1906, and has since been cultivated continuously in Fiji, whilst the other was derived from St. Kitts. Good results were obtained, the yield of lint ranging from 252 lb. to 311 lb. per acre. Both kinds of seed furnished Sea Island cotton of a medium staple, and it is considered that such a product would be more generally useful and more readily saleable than the finer staples, as well as being obtainable in larger yields.

United States of America.—In a paper by Thos. H. Kearney, of the Bureau of Plant Industry, U.S. Dept. Agric., on "Mutation in Egyptian Cotton" (*Journ. Agric. Research*, 1914, **2**, 287), evidence is adduced to show that each of the principal Egyptian varieties originated in a mutant, i.e. an individual plant which showed an abrupt and definite change in the characters expressed. Certain new Egyptian varieties, established in Arizona during recent years, were produced in the same way. Two of these, the Yuma and Somerton varieties, have already been referred to in this Bulletin (1911, **9**, 411), and two further varieties termed "Pima" and "Gila" are now described. The Yuma form is now grown on a commercial scale in the Salt River Valley, Arizona, but the Somerton variety has been abandoned because, although it produced excellent fibre, it was late in maturing, and developed vegetative branches to an excessive extent. The Pima variety appeared in 1910 as a single plant of marked individuality in a field of Yuma cotton; it yields fibre $1\frac{5}{8}$-$1\frac{3}{4}$ in. long, and of a pale buff colour with a tinge of pink. The Gila variety was discovered similarly in a field of acclimatised Mitafifi; it bears fibres about $1\frac{7}{16}$ in. long, and of a somewhat darker colour than that of the Yuma and Pima varieties.

Tobacco

Bulletin No. 79, *U.S. Dept. Agric.*, entitled "Research Studies on the Curing of Leaf Tobacco," records experiments designed to compare the chemical changes which take place during the different methods of curing. The results show that in the curing of leaves which have been picked from the stalk the chemical changes are almost wholly due to respiration, while in curing leaves on the stalk the transference of amino compounds from the leaf to the stalk plays an important rôle. The picked leaves after curing contain larger quantities of amino compounds, mineral matter, and nitrate than the leaves cured on the stalk. In both cases, however, curing causes a large decrease in protein, often amounting to 60 per cent. of the amount originally present. It has been shown that in the case of cigar wrapper leaf types the average loss in weight of dry matter in the curing of picked leaves is 12 to 15 per cent., while in curing leaves on the stalk the loss is twice as great. In the curing of export and manufacturing types and of cigar filler types, which are harvested in a more mature condition, the loss in weight of dry matter is greater than in the case of cigar wrapper leaf, frequently amounting to 35 to 40 per cent., even when leaves are picked from the stalk. In the case of export types, where the stalks are usually split in harvesting, the loss in dry matter is considerably less than when the stalk is simply severed at the base.

FORESTRY AND FOREST PRODUCTS

Eucalyptus planting in Nyasaland.—The satisfactory growth of the Eucalyptus plantations at Zomba is referred to by the Chief Forest Officer in his report which appears in the *Ann. Rep. Dept. Agric., Nyasaland*, 1913–14. Limited quantities of poles and firewood are now being supplied to the Public Works Dept. from the oldest plantation, which was started about six years ago. This plantation is yielding at the rate of 2,455 cubic feet of solid wood fuel (= 3,437 cubic feet of stacked fire-wood) per acre, which is a higher yield than can be obtained from any other tree, either exotic or indigenous, in Nyasaland. In view of the fact that there is now little tree-growth in the more densely populated parts of the country, the Forestry division is endeavouring to induce the natives of those parts to plant up small areas of quick-growing trees in the neighbourhood of villages for the production of poles for hut-building and fuel for domestic use. A large number of seedling Eucalyptus trees have been issued free to natives for this purpose.

Experiments have also been conducted with a view to ascertaining the most suitable soil on which Eucalypts may be expected to give the most satisfactory crop of poles and firewood at an early age under ordinary conditions. So far, the best growths have been obtained on deep, chocolate-coloured, clayey loam and on drained swamp land. On poor, thin soil and dry, stony ridges, Eucalypts have proved more or less a failure. Good results have been obtained at Zomba, on land infested with termites, by planting Eucalyptus trees 4 × 4 or 4 × 3 ft. apart instead of 8 × 8 ft., which is the usual distance, as this allows for thinning by the termites. For the production of poles and fuel at an early age the following species have been found to give the best results:—*Eucalyptus tereticornis*, *E. rostrata*, *E. saligna*, *E. dealbata*, *E. rudis*, *E. Maideni*, and *E. citriodora*.

Mangrove Forests in the Philippine Islands.—A survey of the mangrove swamps in the Philippine Islands has recently been undertaken by the local Bureau of Forestry, those areas which lie along the south coast of Mindanao and at the head of Manila Bay being specially studied (*Ann. Rep., Dir. For., Philippine Is.*, 1912–1913, p. 27). Both virgin and cultivated mangrove swamps are found in these islands. Areas of the former kind are situated in Sibuguey Bay on the south coast of Mindanao and are sufficiently extensive to supply bark for one or more large mangrove cutch factories, but owing to the difficulty of disposing of the stripped trees as firewood, the exploitation of the virgin swamps in this district is at present impracticable.

Cultivated swamps exist in the upper part of Manila Bay and stretch from Malabon in the east to Balanga in the west, often for more than ten miles inland. Nipa palms (*Nipa fruticans*) and bacauan (*Rhizophora* sp.) are extensively planted in these parts, the latter being grown for firewood and sold principally in Manila. The supply is inadequate, so that every available portion of the swamps is utilised. The land chosen for planting bacauan is brackish or salt swamp near the edge of the rivers, where it will be affected by the tides, very soft mud being the most suitable soil for rapid growth. Planting takes place usually from May to August. The seedlings for this purpose, after having been gathered from existing plantations, are allowed to wilt for a fortnight in a shady place. In this condition, they are simply pushed a short distance in the mud so as to stand erect. Cultivation consists principally in keeping the plantations free from vines, but is usually scarcely necessary. The rotation adopted for bacauan cultivation as firewood is from eight to eleven years.

Several species of mangrove trees yield wood of good durability which can be successfully employed as piles, and durability tests are now being carried on to determine whether bacauan wood can be recommended for this purpose.

Besides these swamps in Mindanao, whose area is computed at 130,000 hectares (502 sq. miles), others of importance are found in various other parts of the Philippines.

Timbers

Panama Timbers.—With the opening of the canal it is expected that the timber industry of Panama will experience considerable development, as hitherto the cost of handling and transport before final shipment has limited the industry. According to the Report for the year 1913 on the Trade of the Republic of Panama (*Dipl. and Cons. Rep.* No. 5,338, *Ann. Ser.* [Cd. 7048-155], 1914), the chief woods which now pass through the port of Panama are cocobolo, mahogany, espavé, and guayacan, which come from the Bayano River district and from the Darien region. A supply of cocobolo exists in the hinterland of Chuman, and further inland is a good quantity of mahogany which it is said could be cut and brought down to the coast without much difficulty. Mahogany also exists in the Province of Los Santos in the neighbourhood of Tonosi, but owing to the necessity of transporting it by rail across the Isthmus it is doubtful if it could at present be exploited with profit, but with the canal in operation it should be possible to load direct into steamers at Balboa. Facilities for sawing timber in Panama are at present lacking.

Gums and Resins

Copal.—The copal forests on the Kassewe Hills of Sierra Leone have been surveyed recently and a reserve has been constituted, as it was found that the trees have been severely overtapped and a large proportion of the standing stock consequently killed outright. The trees will probably be allowed a rest of five or six years in which to recover before being tapped again. Those portions of the reserve which have been clear felled and farmed will be replanted with copal trees. The reserved area, 5,767 acres in extent, should yield from 80 to 100 tons of copal per annum (*Ann. Rep. For. Dept., Sierra Leone*, 1913, p. 1).

According to the *Board of Trade Journal* (1914, **85**, 778), a company with a capital of £30,000 has been formed to carry on dredging operations for the recovery of kauri "gum," which exists in large quantities in many of the swamps in the Northern Peninsula, New Zealand. A gold dredger has been purchased and altered for "gum" dredging. Operations are expected to be started this year. The swamps, after having been dredged, will be drained, and are expected to make an excellent dairying country.

Gum Arabic.—Since the fall in prices at the end of 1912, the gum trade of the Anglo-Egyptian Sudan has pursued a quiet course (*Ann. Rep. Cent. Econ. Bd., Sudan*, 1913, p. 7). The exports for 1913 were considerably smaller than those for 1912, being in 1913 15,129 tons, valued at £380,816, against 19,615 tons in 1912, valued at £618,599. This decrease in output is ascribed to the previous over-production and to the fact that the native collectors have been less active owing to the lower prices obtainable. Of the amount exported in 1913, 3,641 tons were sent to France, 2,983 tons to Germany, and 2,821 tons to the United Kingdom.

Experiments are being carried on by the Forest Department to discover whether the cultivation of gum trees, in combination with forest catch crops, can be made to pay, and to show to what extent the quality and quantity of gum can be influenced by cultivation. An area of 1,000 acres at Um Ruaba in the Kordofan Province has been sown with the seed of the "hashab" gum tree, together with sesame seed. The plantation can be said to be on the whole in very fair condition in spite of difficulties as to labour supply and bad rains. From these trials, it should be possible to ascertain the yield of gum per tree during various periods of growth, the age to which a tree will continue productive, the average yield per acre on different soils, the best methods of tapping, and the cost of cultivation and net profit per acre.

Tanning Materials

Mangrove Bark.—*A Note on the Mangrove Forests of British India*, by R. S. Pearson, F.L.S. (Calcutta: Superintendent, Government Printing, 1914), discusses the possibility of utilising Indian mangrove bark commercially. Up to the present this tanning material has not been exported from India to Europe on a commercial scale, although large quantities are annually imported into Calcutta from the Sunderbans, and on a smaller scale into Rangoon and Moulmein from the coastal forests of British Burma.

The most important mangroves found in British India are *Rhizophora mucronata*, Lamk., *R. conjugata*, Linn., *Ceriops Candolleana*, Arn., *C. Roxburghiana*, Arn., *Kandelia Rheedii*, W. and A., and *Bruguiera gymnorrhiza*, Lam., while the largest forests are situated on the Arakan and South Tenasserim coasts, the Sunderbans, Andaman Islands, and to a less extent on the Bassein coast of British Burma.

Information is furnished as to the cost of collection of the bark, the quantities available, suitable localities for factories, labour, and local conditions. The Arakan and South Tenasserim districts are considered the two most promising areas available for the collection of the bark and its manufacture into a tanning extract in British India. The author states that the possibilities of utilising these mangrove barks commercially for tanning extract are fair to good, according to the locality selected.

Wattle Bark.—According to the *Ann. Rep. Dept. Agric., Brit. East Africa*, 1912–13, p. 14, the conditions in the East Africa Protectorate are considered to be slightly more favourable for the cultivation of wattle than in Natal, the prices realised for the small quantities of bark already marketed being larger than those secured for Natal bark, and the yield per acre being as much as 6 tons, as compared with about 4½ in Natal. The Natal planters, however, have the advantage of lower freight charges. It is estimated that from 7,000 to 7,500 acres of land have been planted with wattle in the Protectorate, but that the area of the plantations ready for stripping does not exceed 300 acres; after the lapse of another two years the annual output of bark should amount to 7,500 tons. It is feared that some difficulty may be experienced in air-drying the bark in the Kikuyu and Limoru districts, owing to the higher humidity of the atmosphere in those parts. Experiments are being undertaken at the Kabete Experimental Farm in the artificial drying of wattle bark. When the output reaches 7,000 tons of bark per annum it is hoped that a factory for the manufacture of tanning extract for export will be erected in the East Africa Protectorate.

ECONOMIC MINERALS

Asbestos.—In an article on the asbestos resources of the Thetford area in Quebec (*Monthly Bulletin* No. 27, 1914, *Can. Min. Inst.*) W. J. Woolsey estimates that 600,000 tons of asbestos rock, carrying 12 per cent. of asbestos, was treated prior to 1898. From 1898 to the present time 9,000,000 tons of rock, carrying 6 per cent. of abestos, has been treated.

The deepest points yet attained in quarrying are about 200 ft., at which depth, in all cases, the asbestos-bearing rock has been proved to exist in undiminished quantity. Assuming an average depth of 180 ft., and taking into consideration the boundaries of the asbestos deposit as mapped, it is estimated that there should be no less than 180,000,000 tons of asbestos-bearing rock, or a supply, at the present rate of production, sufficient for ninety years.

The chief reasons given for the apparent decrease in the value of the asbestos-bearing rock are (1) the rock is less carefully selected than formerly; (2) there has been an increase in the number of fibre producers owing to the adoption of the mechanical method of treating the rock; (3) there is a narrowing of the veins as greater depth is attained.

In a discussion appended to this paper, J. A. Dresser, who prepared the map on which the above estimate is based, remarks that the "spottiness" of the asbestos deposits makes such calculations as those of Mr. Woolsey extremely hazardous. The map on which the calculation is based is merely a preliminary one. Detailed larger scale maps are now being prepared by the Department of Mines at Ottawa to show the features of certain small but important parts of the serpentine belt; and these will afford a safer basis for making an estimate of the resources. Mr. Dresser is content for the present with the knowledge that the known reserves of the principal mines are large, and that further prospecting is likely to increase them greatly.

Coal.—In a publication issued by the Canadian Commission of Conservation (Toronto: The Bryant Press, Ltd., 1914), W. J. Dick, the mining engineer of the Commission, deals with the conservation of coal in Canada. He points out the desirability of appointing an engineering authority to guard against wasteful methods in mining. In some instances where there are several seams close together, the lowest is worked first, with the result that caving in occurs, and the mining of the upper seams is rendered impracticable. Much coal has been lost through carelessness in development, and it is claimed that in such instances the opinion of an engineering authority would have been useful in preventing loss.

At some mines, there is a considerable waste of slack

coal. An investigation of mines in Saskatchewan, Alberta, and British Columbia showed that the waste of unmarketable slack coal was from 10 to 35 per cent. of the output. This waste slack is dumped on the ground in some places; whilst on Vancouver Island, some of the producing mines dump as much as 10 to 15 per cent. of their output into the sea as waste slack.

The question as to the possibility of using low-grade coals, and preventing the waste of slack coal, is one of importance from the conservation point of view; and it is suggested that investigations should be carried on by the Government to determine the suitability of these materials for use as gas-producer fuel, and for the manufacture of briquettes for domestic use.

Many other aspects of the problem of conservation in coal mining are considered, and a detailed account is given of the work carried on in the coal mines of Nova Scotia, Saskatchewan, Alberta, and British Columbia.

Osmiridium.—In *Bulletin* No. 17, 1914, *Geol. Surv. of Tasmania*, W. H. Twelvetrees gives an account of the Bald Hill osmiridium field. Bald Hill is in the Heazlewood district in the north-western portion of the island. Geologically, Bald Hill forms part of a mass of serpentinised rocks that lies on the east of the granite of the Meredith Range. On the western side of the hill these serpentinised rocks are in contact with slates of the Dundas Series, of pre-Silurian age, but there is no evidence of metamorphism in the latter.

The osmiridium is obtained from the sands of the Savage river and those of the Nineteen Mile Creek and its tributaries. The mineral for the most part lies on the bottom, though a good deal is obtained by washing superficial material. The creek floors consist of "cement" which is hard enough to require blasting.

The general way of winning the material is to dig up the floor of the creeks with picks, or blast it, the material thus obtained being put into riffled sluice boxes. The material of the creek floor has sometimes to be broken up to the depth of a foot or more in order to get the osmiridium, which has settled into the crevices of the rock. The grains obtained are mostly small; the largest hitherto obtained weighs 9 dwt.

Osmiridium has also been obtained from the solid serpentine by crushing the rock and concentrating. This fact of the proved occurrence of osmiridium in the serpentine rock is of considerable interest, as the Bald Hill occurrence is the only one that has been definitely proved outside Russia, where osmiridium occurs in olivine rocks at Nijni Tagilsk.

A sample of Tasmanian osmiridium, examined at the Imperial Institute, consisted of loose metallic grains vary-

ing in colour from tin-white to yellowish-grey. Half the grains averaged about 1 mm. in diameter, and the other half about 0·5 mm. The sample was found on analysis to have the following composition :

		Per cent.
Platinum	Pt	0·37
Ruthenium	Ru	8·19
Palladium	Pd	0·21
Gold	Au	0·04
Iron	Fe	0·30
Copper	Cu	trace
Iridium and Rhodium	Ir and Rh	33·80
Osmium (by difference)	Os	57·09

The output of Tasmanian osmiridium in 1911 was returned as 272¾ oz., and in 1912 as 778¾ oz. The quantity won is largely determined by the nature of the season, as the "wash" in the Savage river can only be worked when the water is low.

Ozokerite.—According to the *Engineering and Mining Journal* (1914, **98**, 733), deposits of ozokerite or mineral wax occurring near Soldier's Summit and Colton in Wasatch and Utah counties, U.S.A., have recently been examined by Messrs. Day and Robinson, of the U.S. Geological Survey. The ozokerite occurs in veins that have a north and south trend, traversing sandstone and shale. These veins are fracture zones, varying from a few inches up to 12 ft. in thickness, and are impregnated with ozokerite. Some of the deposits carry as much as 3 per cent. of ozokerite. Occasionally there are found lenses of the pure mineral, from 1 to 2 ft. in thickness and 5 or 6 ft. long, and masses weighing as much as 175 lb. have been obtained. At the time of writing the price of ozokerite was 40 cents per lb., and the advance in price may make it possible to work these Utah deposits. Hitherto supplies of ozokerite have been obtained chiefly from Galicia, where it occurs in veins traversing Miocene sands and clays.

Petroleum.—In the *Monthly Bulletin* No. 27, 1914, *Can. Min. Inst.*, R. W. Brock gives some information relating to the strike of oil in the Dingman Well, near Black Diamond, in the Calgary District, Alberta. In this well oil was struck at a depth of 2,700 ft., and quickly rose to a height of from 2,000 to 2,200 ft. in the well. The oil is a "white oil," consisting of almost pure gasoline, and can be used in its crude state as a satisfactory motor spirit.

The well is situated on the apex of a saddle-like fold which is a mile or so in width, has a north-westerly trend, and dips steeply on both limbs.

The structure is thus favourable, but though a well of such oil is more profitable as a producer than a well of similar capacity of ordinary crude petroleum would be, it

is not so promising an indication. Experience in other fields has shown that these "white oils" are usually rather limited in quantity. Though, therefore, the strike of oil at the Dingman well is very encouraging, it cannot be regarded as demonstrating the existence of a commercially important field.

Pitchblende.—In *Professional Paper* 90—A, 1914, *U.S. Geological Survey*, E. S. Bastin gives an account of the geology of the pitchblende (uraninite) deposits of Colorado, and also deals briefly with the occurrences of pitchblende in Cornwall, and in the Erzgebirge of Bohemia and Saxony.

Pitchblende occurs in two ways in the United States. It is found in granite pegmatites in North Carolina; and in intimate association with metallic sulphides in certain mineral veins at Quartz Hill, near Central City, Gilpin Co., Colorado. It is only the latter occurrence that is of any commercial importance.

The oldest rocks of the Quartz Hill district are metamorphosed pre-Cambrian sediments, the predominant type being a quartz-mica schist, in which are intruded granites of pre-Cambrian age. Intrusive in both the igneous and metamorphic rocks are stocks and dykes of monzonite and bostonite, of probably Tertiary age.

The mineral veins of the district cut both the pre-Cambrian and Tertiary intrusives. There are two types of veins, viz. (1) the *pyritic type*, in which pyrite and quartz are the chief minerals, and are associated with small amounts of chalcopyrite, tetrahedrite, enargite, fluorite, and rhodochrosite; and (2) the *lead-zinc type*, in which the minerals are galena, zinc-blende, pyrite, chalcopyrite, quartz, and calcite. The lead-zinc veins were formed after the pyrite veins; but it is believed that the two types were merely successive epochs in one great vein-forming period, and that the formation of these veins was genetically connected with the monzonite intrusions.

The pitchblende occurs in intimate association with pyrite and chalcopyrite, in such a way as to show that it was deposited contemporaneously with these minerals. Some specimens of pitchblende show veinlets containing zinc-blende, pyrite, and galena. It is therefore inferred that the pitchblende was deposited during the earlier or pyritic mineralisation; that subsequent to this fracturing took place, and the fractures were filled by sulphides of the later or lead-zinc mineralisation.

Unlike the European pitchblende, that of Quartz Hill is not associated with nickel and cobalt minerals.

NOTICES OF RECENT LITERATURE

The Oxford Survey of the British Empire. Edited by A. J. Herbertson, M.A., Ph.D., and O. J. R. Howarth, M.A. 6 vols. Demy 8vo. Vol. I.: The British Isles and Mediterranean Possessions. Pp. xii + 596. Vol. II.: Asia. Pp. x + 505. Vol. III.: Africa. Pp. xvi + 547. Vol IV.: America. Pp. x + 511. Vol. V.: Australasia. Pp. xii + 584. Vol. VI.: General Survey. Pp. viii + 386. (Oxford: Clarendon Press, 1914). Price £3 10*s.* net; or, separately, 14*s.* net per volume.

In the preface to this series of volumes it is explained that the object is "to furnish a survey of the British Empire and its constituent parts in their geographical and allied aspects, together with their economic, administrative, and social conditions at the present time." To carry out this object the editors have utilised the services of a large number of experts. Thus in the first volume twenty chapters are devoted to the British Isles, the first seventeen dealing with Great Britain and Ireland, and the last three with the Scilly Isles, the Channel Islands, and the Isle of Man, each of the twenty being by a different contributor. The Mediterranean Possessions, Gibraltar, Malta, and Cyprus, are described in Chapters XXI. to XXIII. Each volume also contains a Gazetteer of Towns and a series of statistical tables for the territories dealt with in it. This plan is followed throughout the series, the principal territory in each continent being dealt with in a series of chapters on physical geography and geology, climate, vegetation, fauna, agriculture, economic conditions, population, government and finance, and similar subjects, and the less important territories having, as a rule, one chapter each devoted to them. No objection can be taken to such a plan, but it works out rather curiously in some ways: thus the Channel Islands have thirty pages devoted to them, whilst Nigeria, with a far greater area, population, and potential wealth, has only thirty-nine pages given to it.

From the point of view of readers of this Bulletin volumes II. to V., dealing with the overseas parts of the Empire, are likely to be the most interesting. It is impossible to review the volumes in detail within reasonable limits, and in this notice observations will be confined to the chapters dealing with economic resources. India naturally bulks very largely in Vol. II., dealing with the British Possessions in Asia, and the various chapters on Indian subjects are contributed by well-known authorities, who have acquired their information at first hand. Geology is dealt with by Mr. Oldham, Climate by Dr. G. T. Walker, Forestry by Sir S. Eardley-Wilmot, Agriculture and Industrial and Economic Conditions by Mr. J. S. Cotton.

In Vol. III. Mr. A. D. Hall gives a short but very good account of agriculture in the Union of South Africa, which is supplemented usefully on the economic and statistical side in the next chapter on "Economic Conditions and Communications," by the late Sir Richard Solomon, which includes a good account of the mining industries. The "Physical Geography and Geology" of the area are dealt with in Chapter I. by Dr. Rogers, Assistant Director of the Geological Survey of the Union. Chapters IX. to XXII., which deal with the Crown Colonies and Protectorates in Africa, each chapter being by a different author and concerning a single administrative unit, vary a good deal in their contents and quality, but they are all interesting, and for the most part adequate in treatment and up to date in their information.

Of the sixteen chapters forming Vol. IV., dealing with the British Territories in America, nine are devoted to Canada, one to Newfoundland, one to Labrador (by Dr. Grenfell), three to the West Indies, including British Guiana, and one to the Falkland Islands (by Dr. W. S. Bruce). A chapter might very well have been devoted to the agricultural and mining industries of Canada. Though these subjects are fairly exhaustively covered in Prof. Mavor's three chapters of Economic Survey, more technical as distinct from broadly economic information would have been useful, especially as regards agriculture in Canada.

Mr. Aspinall describes the topography, population, and government of the West Indies, while Sir Daniel Morris contributes two chapters dealing with Geology, Climate, Vegetation, and Fauna, and with Economic Conditions respectively.

Vol. V. is devoted to Australasia, and begins with an excellent chapter by Sir George Reid, entitled "Introductory Survey and Government." "Communications" and "Economic Conditions and Industries" are the titles of two very interestingly written chapters by Mr. Gullett, London Correspondent of the *Sydney Daily Telegraph*. "Mining and Economic Geology," by Mr. Griffith Taylor, summarises very well existing knowledge of the mineral resources of the Commonwealth.

Chapter XI., by Prof. P. Marshall, deals with the topography, geology, climate, etc., of New Zealand, while the Economic Conditions and the Population and Government of the same Dominion are described by Sir Robert Stout and Mr. T. Logan Stout.

Chapter XVI., by Mr. Griffith Taylor, deals with the British Sector of Antarctica.

Vol. VI. is a General Survey of Imperial problems of administration, defence, education, acclimatisation, commerce, communications, migration, etc., and naturally at

the present time, when statesmen are so much concerned with questions of Imperial organisation, it forms the most interesting volume of the series, fascinating as the others are in their broad display of the vast resources of the Empire.

The Oxford Survey of the British Empire is a production on which the publishers, the contributors, and, most of all, the editors can be heartily congratulated. The articles are all well written, interesting, and informative, and the maps and illustrations are abundant and good. The Clarendon Press has published many good books, but certainly none which excels this in interest to citizens of the British Empire.

THE POCKET GUIDE TO THE WEST INDIES, BRITISH GUIANA, BRITISH HONDURAS, THE BERMUDAS, THE SPANISH MAIN, AND THE PANAMA CANAL. By Algernon E. Aspinall. New and Revised Edition. Pp. viii + 488, Fcap. 8vo. (London: Duckworth & Co., 1914.) Price 5*s*. net; post free, United Kingdom 5*s*. 4*d*., abroad 5*s*. 6*d*.

Since its publication in 1907 this "Guide" has been the indispensable *vade mecum* of all travellers and tourists in the West Indies. The general plan of the volume has been referred to in previous reviews in this BULLETIN. In the present edition the book has been rewritten to a considerable extent, and the scope of its usefulness enlarged by the inclusion of several admirable articles, notably those dealing with the Bermudas, the Bahamas, and British Honduras; whilst the section on the Panama Canal has been extended to include Colon and Panama.

Practical experience of the "Pocket Guide" shows it to be an almost ideal guide-book, lacking but two requirements—viz. a reasonably large map of the Caribbean, printed on strong paper and opening clear from the book; and a thin-paper edition.

ON THE TRAIL OF THE OPIUM POPPY. By Sir Alexander Hosie, M.A., LL.D., F.R.G.S. 2 vols. Vol. I., pp. viii + 300. Vol. II., pp. 308. Demy 8vo, photographs, 2 coloured maps and index. (London: George Philip & Son, Ltd.; Liverpool: Philip, Son, & Nephew, Ltd. 1914.) Price 25*s*. net; post free, United Kingdom 25*s*. 6*d*., abroad 26*s*. 6*d*.

A straightforward and minutely detailed narrative of journeys made during 1910 and 1911 by the author (the well-known late British Consul-General at Tientsin) in the chief opium-producing provinces of China. The prime purpose of Sir A. Hosie's mission was to investigate the extent of poppy-cultivation in those north-western and western provinces, which had hitherto been the chief centre of its production. By an Imperial decree of September 20,

1906, the restriction of the cultivation of the poppy throughout China was ordered, and the term of ten years fixed for the complete prohibition of its use. The results of Sir A. Hosie's investigation as to how far in three and a half years the Chinese authorities had actually put their repressive work into force have already been made public in parliamentary papers, though they are briefly summarised again in the present volumes. The principal object of this book, however, is to point out the physical characteristics and economic conditions of those provinces—Shansi, Shensi, Kansu, Szechuan, Yünnan, and Kueichou—through which the author travelled, under Chinese official auspices, in a litter resembling a large sedan chair, but carried by mules instead of men, and consistently, we gather, uncomfortable.

Sir A. Hosie is an extremely careful observer. Nothing in his tedious transit seems to have escaped his curious eye, which neither heat nor cold nor make-shift accommodation at villainous inns with its attendant insect miseries could dim. He sees a lump of coal at one place in a yard, and promptly finds out whence the local supply is obtained and exactly what it costs; at another place he notes the small factories turning the bamboo forests into paper. His observation is, where necessary, backed up by a draft on his comprehensive knowledge of Chinese agriculture and plant life and of Chinese economic products generally. A meeting with a crop of the fibre-yielding plant *Abutilon Avicennae* in full bloom draws from him a most informing little dissertation on Chinese fibre-plants generally; the sight of a Catalpa tree reminds him of the use made of its wood by the Chinese in furniture. If at first—as in truth rarely happens—he is puzzled, the mystery does not long remain one. For a time he could not understand why each house in a certain hamlet had usually a patch of *Boehmeria nivea*, or China grass, attached to it. But the next hamlet a little farther on supplied the answer. "All its houses had on sale straw sandals, which are usually worn by wayfarers, and the fibre of China grass is used as cord for weaving and binding the straw together."

Amongst crops special attention was paid by Sir A. Hosie to the Chinese variety of lucerne (*Medicago sativa*), which he considers might be introduced with great advantage into Great Britain and the Dominions, inasmuch as it grows well up to an altitude of 4,000 ft.—"fears neither drought nor deluge, and once sown seems to require no further attention. It yields at least three crops a year, is eagerly devoured by cattle, and is reported to have excellent fattening qualities." The author procured a quantity of the seed of this lucerne, which was distributed by the Board of Agriculture in Great Britain, Canada, and South Africa. The results have been satisfactory, especially in South

Africa, whence a requisition for half a ton of seed was sent to China in 1912.

On the Trail of the Opium Poppy, which is fortunately well indexed, is, briefly, nothing less than a considerable contribution towards an encyclopædia of Chinese economic products. Its modest title covers a wealth of observation, of industry, and of knowledge.

THE PAN-ANGLES. By Sinclair Kennedy. Pp. ix + 244, Demy 8vo. (London: Longmans, Green & Co., 1914.) Price *7s. 6d.* net; post free, United Kingdom *7s. 10d.*, abroad *8s.*

This is a "consideration of the federation of the seven English-speaking nations"—the United Kingdom, Canada, Newfoundland, the Australian Commonwealth, New Zealand, the Union of South Africa, and the United States, written by an American. Mr. Kennedy points out that Benjamin Franklin, in 1754, initiated the thesis of these pages when he foresaw the need of a single Government based on the representation of both the American and British groups of self-governing English-speaking people. Mr. Chamberlain expressed it in general rhetorical terms when, speaking before a Canadian audience in 1897, he refused to make any distinction between the interests of Englishmen in England, in Canada, and in the United States. Mr. Kennedy holds that only by the union of all of these English-speaking nations can the integrity of any one of them be preserved in the face of the growing strength of China, of Russia, and of Japan. With Germany he thinks the seven English-speaking nations should form an alliance as a buffer against aggression in other quarters, but his book was apparently finished six months before the outbreak of the present war, and to be wise before the event is of course not easy.

Mr. Kennedy shows the urgent necessity for a real federation of governments (as distinct from a common but vague sentiment in this direction) between the United Kingdom and her nation colonies. If he has not added materially to the existing arguments for that step he has, by copious quotations, brought together in a most useful form the already expressed opinions of others. His plea that the United States should be included in this federation is eloquent, but by no means so convincing. The element of a common personal Sovereignty surely counts for much in the Imperial idea; its cementing influence—sentimental as it may be—is in the opinion of competent observers materially increasing. On what terms could the United States, which admits no such Sovereignty, enter a Pan-Angle Federation? By the way, if a word is to be coined to cover all the English-speaking races, surely even the slipshod English of, say, "Anglians" would be better than

the no English at all, not to say the hideousness, of "Pan-Angles."

Why We are at War: Great Britain's Case. By Members of the Oxford Faculty of Modern History. Pp. 206, Demy 8vo. (Oxford: At the Clarendon Press, 1914.) Price 2*s.*; post free, United Kingdom 2*s.* 4*d.*, abroad 2*s.* 5*d.*

The War and the British Dominions. By H. E. Egerton. Pp. 23, Crown 8vo. (Oxford University Press, 1914.) Price 2*d.*; post free, United Kingdom or abroad, 3*d.*

India and the War. By Sir Ernest J. Trevelyan. Pp. 11, Crown 8vo. (Oxford University Press, 1914.) Price 1*d.*; post free, United Kingdom or abroad, 1½*d.*

One of the very few good features of the present war is the fact that it has made the British people realise the necessity of stating and explaining their instinctive attitude towards European politics.

The first of these Oxford University Press publications is from this point of view alone a most useful and opportune production, since it discusses without bias the causes which the British people are united in believing have given rise to this war and the principles which they think are in hazard. The scope of the book may be indicated sufficiently by quoting the heads of the six chapters into which it is divided. They are: The Neutrality of Belgium and Luxembourg; The Growth of Alliances and the Race of Armaments since 1871; The Development of Russian Policy; Chronological Sketch of the Crisis of 1914; Negotiators and Negotiations (a summary of the official negotiations which preceded the outbreak of war); The New German Theory of the State.

The series of four appendixes includes a reprint of the German White Book, as issued in English by the German Foreign Office.

The second and third publications form two of the series of "Oxford Pamphlets, 1914." The former describes why the British Dominions have rallied in unprecedented fashion to the support of the Mother Country in the present crisis. Sir E. J. Trevelyan's pamphlet discusses British policy in India, mentions some of the difficulties which the government of that country presents to its administrators, and finally describes the splendid and ungrudging support which the princes and peoples of India are now giving to this country.

The Coconut. By Edwin Bingham Copeland. Pp. xiv + 212, Demy 8vo. (London: Macmillan & Co., Ltd., 1914.) Price 10*s.* net; post free, United Kingdom 10*s.* 4*d.*, abroad 10*s.* 7*d.*

This book is written from a somewhat different standpoint from that of the already numerous works on the

coconut, being based on a series of lectures delivered by the author, who is Professor of Plant Physiology in the College of Agriculture of the University of the Philippines.

Climate and soil and the physiology of the plant are dealt with first; following this is a long chapter on diseases and pests; while the remainder of the book covers selection and treatment of seed, field culture, and coconut products. The chapter on diseases and pests is particularly good and contains useful information, both from the author's personal observation in the Philippine Islands and from the experience of investigators throughout the world; it forms, in fact, an excellent résumé of the present state of knowledge with regard to this important subject. It is interesting to note, in view of the frequent references to remedial measures for bud-rot, that the author agrees with other investigators in stating that remedial measures such as disinfection are useless and that destruction of infected trees by burning is the best means of preventing the spread of this disease.

The various aspects of coconut cultivation are well dealt with, but the concluding chapter on coconut products is somewhat disappointing. The native uses of coconut products and their manufacture are adequately dealt with, but the utilisation of copra for the manufacture of coconut oil and cake in Europe and elsewhere is dismissed in less than one page; even admitting that the work is intended primarily as a guide to those interested in the cultivation of the tree, it can hardly be contended that this is adequate treatment of the subject.

The book is eminently readable and well illustrated and will form a valuable addition to the libraries of all who are interested in coconut cultivation.

TIMBERS OF BRITISH GUIANA. By Herbert Stone and W. G. Freeman. Pp. xi + 110, Demy 8vo. (London: Published for the Government of British Guiana by the Crown Agents for the Colonies, 1914.) Price 5*s.* net; post free, United Kingdom 5*s.* 3*d.*, abroad 5*s.* 4*d.*

This book constitutes a report upon a collection of timbers made in British Guiana under the superintendence of the Hon. A. G. Bell, formerly Colonial Civil Engineer. The main objects of the report have been to obtain botanical identifications of the timbers, to collect information already published in regard to them, and to report upon their commercial utility and prospect of entering the English market. The first of these objects has been only partially successful on account of the notorious difficulty of obtaining complete botanical material, the leaves and fruits (only) available having been sufficient in some cases to determine

the species. It is interesting, however, to note that Purpleheart, one of the best known of Guiana timbers, is established as *Peltogyne paniculata*, Benth. In arrangement the book is on the useful lines rendered familiar in "Timbers of Commerce" by one of the authors, and it is evident that much labour and trouble have been expended in providing the detailed descriptions of the woods which will be of great value to timber specialists. Nevertheless, some disappointment is experienced on learning that "most of the specimens in this collection are from young, quickly-grown trees," though comparison with specimens from other sources convinced the authors they "might have expressed a higher opinion of these woods in almost every instance" had more mature samples been available. These facts probably explain the omission of any general summary of the results of this investigation. Nine clearly-printed photo-micrographs form a frontispiece.

The Mechanical Properties of Wood. By S. J. Record. Pp. xi + 165, Med. 8vo. (New York: John Wiley & Sons. London: Chapman & Hall, Ltd., 1914.) Price 7*s.* 6*d.* net; post free, United Kingdom 7*s.* 10*d.*, abroad, 8*s.* 1*d.*

The author, who is Assistant Professor of Forest Products in Yale University, deals in a very able manner with a subject which has received far less attention in this country than it deserves. Much work has been done on the timbers indigenous to certain British Colonies, *e.g.* New South Wales, and the author refers to the more important of these researches, but is in the main indebted to the work of the United States Forest Products Laboratory, Wisconsin, for details of the methods of timber testing and their interpretation. The book is divided conveniently into three parts; Part I. deals with the fundamental properties of woods, such as strength in bending, compression, etc., hardness, and other properties. Part II. discusses the factors affecting the mechanical properties of wood. In this section important questions such as the influence of rate of growth, presence of faults, fungoid attack, and treatment with preservatives, on the quality of wood are discussed. In Part III. the methods of testing woods are described. This section is particularly clear and well arranged; possibly the author might find it advantageous to add in future editions a short discussion of the relative merits of the different types of testing machines which have been employed up to the present for timber testing. A particularly valuable feature is the full bibliography of works and articles dealing with the properties of timber, timber testing, etc.; this is probably the most complete list published up to the present time, and is of great interest and value.

A Text-Book of Grasses: With especial reference to the economic species of the United States. By H. S. Hitchcock. Pp. xvii + 276, Crown 8vo. (New York: The Macmillan Company, 1914.) Price 6*s.* 6*d.* net; post free, United Kingdom 6*s.* 10*d.*, abroad 7*s.* 1*d.*

This book, written by the Systematic Agrostologist to the United States Department of Agriculture, is intended primarily as a text-book for students of systematic agrostology. The first part deals briefly with the economic uses of grasses, including an account of forage plants, pasture and meadow plants, hay, lawn, soil- and sand-binding grasses, weeds, etc. Part II., which occupies the bulk of the book, deals with the morphology of the vegetative and floral organs of grasses, their ecology, and chiefly with classification. Keys for the determination of all the genera found growing wild or in common cultivation in the United States are given, as well as more complete descriptions of the most important genera and species. The nomenclature followed is that of the American code, but synonyms are introduced whenever a species or genus has been commonly known under another name.

A useful list is given of recent publications on the economic uses of grasses issued by the United States Department of Agriculture, and another of books and articles chiefly dealing with the classification of North American grasses.

The book should prove of considerable value to agricultural students in the United States.

Die wichtigsten Krankheiten und Schädlinge der tropischen Kulturpflanzen und ihre Bekämpfung. By Dr. Friedrich Zacher. I Band. Pp. viii + 152, Demy 8vo. (Hamburg: Fr. W. Thaden, 1914.) Price 4 marks; post free, United Kingdom 4*s.* 3*d.*; abroad 4*s.* 4*d.*

This little book is the first volume of a work intended to serve as a practical handbook of tropical plant pests and diseases for the use of agriculturists in the German colonies. The magnitude of the task appears to have been no deterrent to the author, who deals with his subject confidently under the familiar headings of "symptoms," "distribution," "life-history," and "treatment," to which is added, in the case of fungoid diseases, the optimistic "prevention and cure."

The first part, which deals with the general principles of plant sanitation, is an informing introduction to the subject, which would be welcomed by many planters; while the second part, comprising the main part of the book, deals with the characteristic diseases of cotton, cocoa, coffee, and tea, though the last-mentioned crop can

scarcely be regarded as an important culture in any German colony. The section appears to have been carefully compiled, though no claim can be made to completeness. The author takes up a cautious attitude in regard to the important canker of cocoa, and insufficient weight appears to have been given to the important work of Rorer in Trinidad and Petch in Ceylon; indeed, no reference is made to the Ceylon investigations. The book is illustrated, many of the figures being familiar; others, which appear to be original, will have small practical value.

Ore Deposits. By F. Beyschlag, J. H. L. Vogt, and P. Krusch. Translated by S. J. Truscott. Vol. I. Pp. xxviii + 514, Demy 8vo, with 291 illustrations. (London: Macmillan & Co., Ltd., 1914.) Price 18*s.* net; post free, United Kingdom 18*s.* 6*d.*, abroad 19*s.* 3*d.*

This is a translation from the German of the first of three volumes of a well-known and very useful work on economic mineral deposits. The cover of the book carries the familiar title of "Ore Deposits"; but as indicated on the title-page, it is the aim of the book to deal comprehensively with "the deposits of the useful minerals and rocks, their origin, form, and content."

The first half of the volume deals with the morphology, classification, and mineral content of ore deposits. Among other important subjects dealt with at considerable length in this part of the volume are the formation of minerals, and the distribution of the elements in rocks; whilst other smaller sections deal with "the absolute and the relative amounts of the metals in useful ore deposits," "primary and secondary depth zones," and "indications of ore deposits at the surface."

In the second half of the volume there is given an account of the scientific classification of ore deposits. The main subdivisions adopted by the authors are:

1. Magmatic segregations.
2. Contact deposits.
3. Cavity fillings and metasomatic deposits.
4. Ore beds.

Of these subdivisions, magmatic segregations and contact deposits are dealt with in detail in this volume, together with three of the nineteen types of cavity-filling and metasomatic deposits.

The volume is very well illustrated and indexed. English students will feel grateful to Prof. Truscott for having undertaken the careful translation of this useful and authoritative work.

The Mining World Index of Current Literature. Vol. V., first half-year, 1914. By G. E. Sisley. Pp. xxix + 237, Med. 8vo. (Chicago: The Mining World Company 1914.) Price $2; post free, United Kingdom 8*s.* 8*d.*, abroad 8*s.* 11*d.*

This is an international bibliography of mining, compiled and revised semi-annually from the index of the world's current literature published weekly by the *Mining and Engineering World.* All branches of the subject are dealt with, and Vol. V., like its predecessors, is a very thoroughly compiled and useful bibliography.

Phillips' Paper Trade Directory of the World, 1913–14. Pp. lxxx + 914, Demy 8vo. (London: S. C. Phillips & Co., 1914.) Price 15*s.* 6*d.*; post free, United Kingdom 16*s.*, abroad 16*s.* 8*d.*

This useful work is a compendium of information on the world's paper trade. It contains lists of (1) paper mills, arranged under their respective countries; (2) the wood pulp mills, with an indication of the kind of pulp manufactured, whether mechanical or chemical, and in the latter case whether produced by the sulphite, sulphate, or soda process; (3) buyers of paper, boards, and stationery in all parts of the world; (4) millboard makers, enamellers, paper stainers, paper agents, exporters, paper stock merchants, wholesale stationers, and paper box and bag makers; and (5) registered water-marks of the various mills and stationery firms. Information is also given on the various paper-makers' associations and the paper trade customs of different countries, and a glossary of commercial and trade terms in six languages is provided.

The new issue of the directory has been brought up to date in all particulars, and will doubtless be of great value and utility to all engaged in paper-making and the various branches of the paper trade.

Practical Tropical Sanitation. By W. Alex. Muirhead. Pp. xiv + 288, 8vo. (London: John Murray, 1914.) Price 10*s.* 6*d.* net; post free, United Kingdom, 10*s.* 10*d.*, abroad 11*s.* 2*d.*

A knowledge of tropical hygiene is indispensable to those occupying Sanitary Inspectorships in tropical colonies, and the Colonial Office now requires a certificate of competency in the science from candidates for appointments of this kind on the West Coast of Africa. The present work is intended specially for the use of candidates for tropical sanitary appointments. In addition to the practical applications of hygiene, it deals briefly, but lucidly, with the fundamental principles of disease causation and prevention, and the preservation of health.

After a general account of the causes of disease, the chief tropical diseases are described and the preventive measures to be taken in each case dealt with. Special attention is devoted in the latter connection to disease-bearing mosquitoes and other flies. Subsequent chapters deal with disinfection; the composition of the atmosphere and the subject of ventilation; water and water supplies; food, including an account of the diseases of animals used for food; the collection, removal, and disposal of excreta and refuse; habitations; and a brief outline of sanitary law and a discussion of the practical application of hygienic principles. An appendix contains a number of useful notes, tables, and formulæ.

The book is very well printed and contains numerous illustrations. It should prove useful not only to Sanitary Inspectors, but to estate managers, mine owners, and others in the tropics concerned with the welfare of employees.

BOOKS RECEIVED

COCOA. By Dr. C. J. J. van Hall. Pp. xvi + 515. (London: Macmillan & Co., Ltd., 1914.) Price 14*s.* net; post free, United Kingdom 14*s.* 6*d.*, abroad 15*s.*

ELEMENTS OF FORESTRY. By F. F. Moon and N. C. Brown. Pp. xvii + 392. (New York: John Wiley & Sons; London: Chapman & Hall, 1914.) Price 8*s.* 6*d.* net; post free, United Kingdom 8*s.* 11*d.*, abroad 9*s.* 3*d.*

AN INTRODUCTION TO THE GEOLOGY OF NEW SOUTH WALES. By C. A. Süssmilch. 2nd. ed. Pp. xviii + 269. (Sydney: Angus & Robertson, Ltd.; London: The Oxford University Press, 1914.) Price 7*s.* 6*d.* net; post free, United Kingdom 7*s.* 10*d.*, abroad 8*s.* 2*d.*

THE GUIDE TO SOUTH AND EAST AFRICA. Edited by A. Samler Brown and G. Gordon Brown. 21st ed. Pp. liv + 694. (London: Sampson, Low, Marston & Co., Ltd., 1915.) Price 1*s.*; post free, United Kingdom 1*s.* 4*d.*, abroad 1*s.* 8*d.*

LE TURKESTAN RUSSE. By A. Woeikof. Pp. xii + 360. (Paris: Armand Colin, 1914.) Price 8 frs.; post free, United Kingdom 6*s.* 8*d.*, abroad 6*s.* 11*d.*

HANDBOEK VOOR CULTUUR-EN HANDELSONDERNEMINGEN IN NEDERLANDSCH-INDIË, 1915. Pp. xix + 1638 + 218. (Amsterdam: J. H. de Bussy, 1914.) Price 10 florins; post free, United Kingdom 17*s.* 2*d.*, abroad 18*s.* 1*d.*

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Botanical names and titles of books reviewed are printed in italics.

PRINTED BY
HAZELL, WATSON AND VINEY, LD.,
LONDON AND AYLESBURY,
ENGLAND.

The Tropical Agriculturist
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PUBLISHED MONTHLY

Subscription, Ceylon:– Rs. 8 per annum
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The "T. A." was started in June 1881 and has been published regularly ever since. As a magazine of information regarding products suited for cultivation in the tropics it is unrivalled. Tea, Rubber, Cacao, and Coconuts are freely discussed, while a feature of the Journal is the attention paid to minor and new products. The "T. A." was one of the first papers to recommend rubber planting—a South Indian planter writing us when the rubber boom was on, in 1907, said that if he had followed the advice to plant rubber when first given to planters in the "T. A." more than a decade before, he would then have been at home on retirement. Sir W. T. Thiselton-Dyer, F.L.S., C.M.G., of Kew Gardens, wrote: "Sir Joseph Hooker and myself always look out for the successive numbers of the 'T. A.' with eagerness, and I keep a file in my office for reference; it is impossible to speak too highly of the utility of such a publication and of the way it is managed."

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